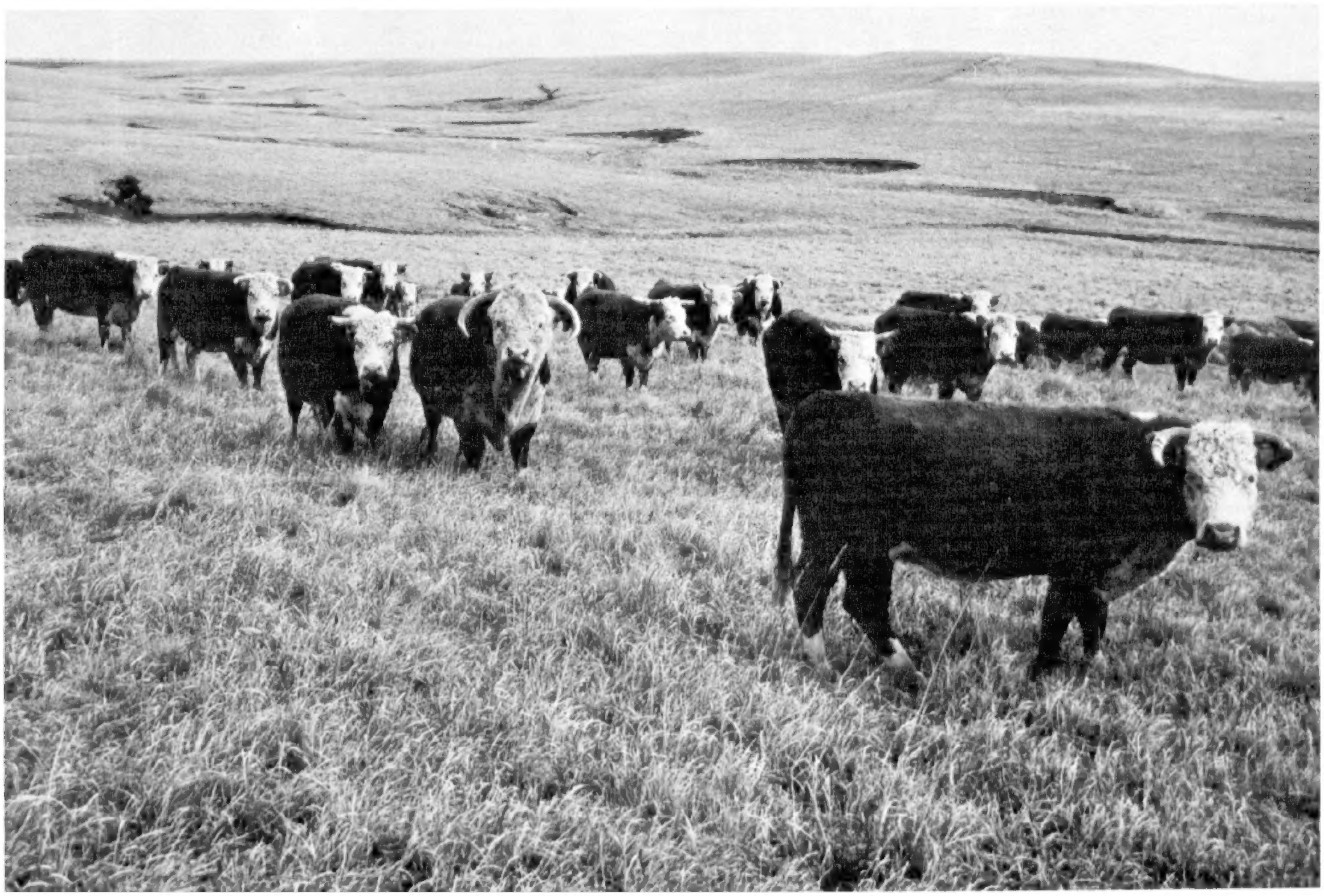
SOIL SURVEY OF

Chase County, Kansas



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Kansas Agricultural Experiment Station

Issued June 1974

Major fieldwork for this soil survey was done in the period 1957–1966. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1967. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Chase County Soil Conservation District.
Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Chase County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It shows the page where each soil is described and the page for the range site. It also shows the woodland suitability group and windbreak suitability group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units.

Foresters and others can refer to the section "Use of the Soils for Woodland and Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Use of the Soils for Wildlife."

Ranchers and others can find, under "Use of the Soils for Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Chase County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

Cover: An area of the Florence-Labette association in the Bluestem Hills. Cattle are wintered on this association.

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SOIL SURVEY OF CHASE COUNTY, KANSAS

BY JAMES T. NEILL, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION[1]

CHASE COUNTY, in the east-central part of Kansas (fig. 1), has a land area of 774 square miles, or 495,360 acres. Cottonwood Falls, the county seat, is in the north-central part of the county.

Raising livestock is the most important enterprise in the county. Much of the range is used for summer grazing of livestock. Cultivated areas are used mainly for the production of feed. Corn, sorghum, alfalfa, and bromegrass are produced in the county and are used mainly for feed. Some cash-grain crops, such as wheat and soybeans, are also grown. Raising beef cattle is the main livestock enterprise. Production of swine, sheep, and poultry, and processing of dairy products are of lesser importance.

The full feeding of cattle makes up a major part of the economy of the county.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Chase County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

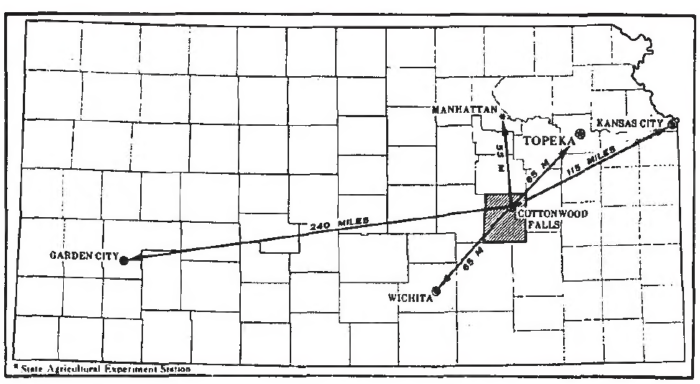


Figure 1.—Location of Chase County in Kansas.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The soil series and the soil phase are the categories of soil classification most used in a local survey (*10*).[2]

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Irwin and Sogn, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Tully silty clay loam, 3 to 7 percent slopes, is one of several phases within the Tully series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of

[1] LEE W. COLLINSWORTH, district conservationist, Soil Conservation Service, also took part in the fieldwork.

[2] Italic numbers in parentheses refer to Literature Cited, p. 64.

Chase County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Clime-Sogn complex is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. The name of an undifferentiated group consists of the names of the dominant soils, joined by "and." Alluvial land and Reading soils is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Stony steep land is a land type in Chase County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others; then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Chase County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The six soil associations in Chase County are discussed in the following pages.

1. Labette-Irwin association

Gently sloping and sloping, moderately deep and deep soils that have a subsoil of silty clay; on uplands

This association (fig. 2, p. 3) consists of 74,300 acres, or about 15 percent of the county. Most of the association is gently sloping or sloping, but there are some steep, rocky slopes along the drainageways.

Labette soils make up about 40 percent of the association; Irwin soils, about 30 percent; and minor soils make up the rest. These soils formed over limestone and shale.

Labette soils have a surface layer of dark grayish-brown silty clay loam about 10 inches thick. The subsoil is firm silty clay. These soils are underlain by limestone or shale at a depth of 20 to 40 inches. They are well drained. Permeability is slow.

Irwin soils have a surface layer of dark grayish-brown silty clay loam about 11 inches thick. Their subsoil is very firm silty clay. These soils are moderately well drained to well drained. Permeability is very slow. Dwight soils make up 10 percent of the association. They have a thin surface layer over a subsoil of dense silty clay. They occur in more nearly level areas, just above limestone outcrops. In places Dwight and Labette soils occur as a complex. Sogn soils make up 11 percent of the association. They are not suitable for cultivation, because they are shallow and rocky. Tully, Reading, Ladysmith, and Clime soils make up the remaining 9 percent of the association.

About half of the association is cultivated, and the rest is used for range. The soils are eroded in many of the cultivated areas. Most of the farmers raise grain and beef cattle. Crops respond well to fertilizer and to conservation treatments.

Good gravel roads run along about half of the section lines.

2. Florence-Labette association

Gently sloping to strongly sloping, deep and moderately deep soils that have a subsoil of cherty clay or silty clay; on uplands

This association (fig. 3, p. 4) is in areas locally called the Flint Hills. It consists of 207,110 acres, or about 42 percent of the county. Most of the association is sloping or strongly sloping, but there are some gently sloping areas and some steep, rocky ones along drainageways.

Florence soils make up about 28 percent of the association; Labette soils, about 19 percent; and minor soils

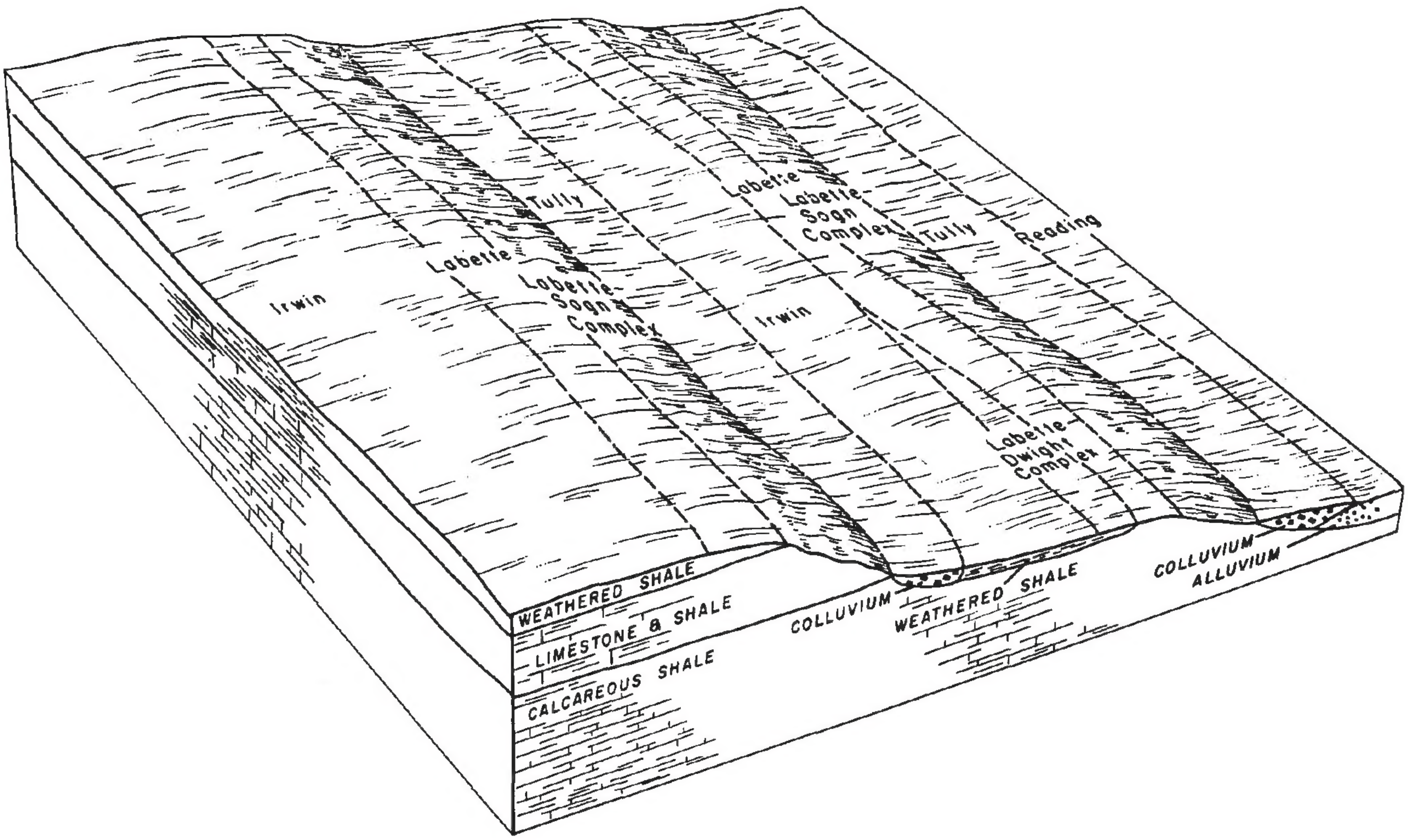


Figure 2.—**Pattern of soils in the Labette-Irwin association.**

make up the rest. These soils formed over limestone, cherty limestone, and shale. They are well drained. Permeability is moderately slow.

Florence soils have a surface layer of dark grayish-brown cherty silt loam about 13 inches thick. The upper part of the subsoil is firm, heavy cherty silty clay loam about 7 inches thick. The lower part of the subsoil is very firm, coarse cherty clay about 22 inches thick. These soils are underlain by cherty limestone. They are well drained.

Labette soils have a surface layer of dark grayish-brown silty clay loam about 10 inches thick. The upper part of the subsoil is firm heavy silty clay loam about 5 inches thick. The lower part is firm silty clay about 19 inches thick. These soils are underlain by limestone at depths of 20 to 40 inches. They are well drained. Permeability is slow.

Irwin soils, which make up about 9 percent of the association, have a subsoil of very firm silty clay. Dwight soils, which make up about 8 percent of the association, have a thin surface layer and a subsoil of dense silty clay. They occur in the more nearly level areas just above limestone outcrops. In places Labette and Dwight soils occur as a complex. Sogn soils make up about 8 percent of the association. These soils are not suitable for cultivation, because they are shallow and rocky. Tully soils make up about 15 percent of the association. These soils are strongly sloping. Matfield and Reading soils and areas of Stony steep land and Alluvial land make up the remaining 13 percent of the association.

Practically all of the association is in native range. A few small fields are cultivated. The raising of beef cattle is the main farm enterprise in this association. Most of the cattle grazed are not locally owned. They are summer grazed for 4 or 5 months, and after the grazing season they are shipped to markets and feedlots.

There are few roads, other than trails, in most of this association.

3. *Reading-Tully association*

Nearly level to sloping, deep soils that have a subsoil of silty clay loam or silty clay; on terraces and uplands

This association (fig. 4, p. 5) consists of 59,400 acres, or about 12 percent of the county. About half of it consists of nearly level soils on valley floors, and the rest of sloping soils along the sides of valleys.

Reading soils make up 50 percent of the association; Tully soils, about 30 percent; and minor soils make up the rest. These soils formed in alluvium or slope wash from nearby areas.

Reading soils have a surface layer of dark grayish-brown silt loam about 17 inches thick. The upper part of the subsoil is firm silty clay loam about 7 inches thick. The lower part is firm silty clay loam. Reading soils are well drained; permeability is moderately slow.

Tully soils have a surface layer of very dark grayish-brown silty clay loam about 14 inches thick. The upper

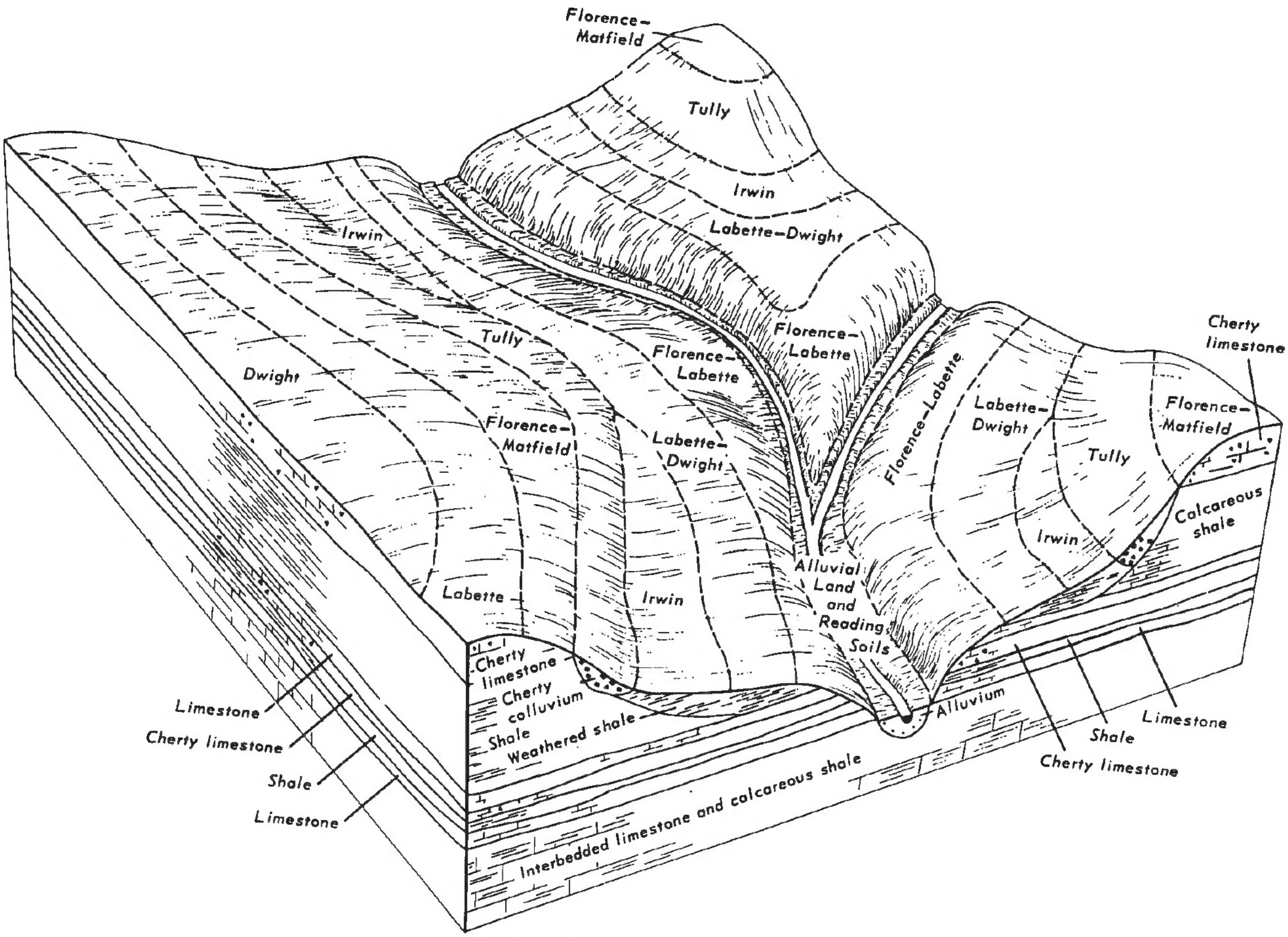


Figure 3.—**Pattern of soils in the Florence-Labette association.**

part of the subsoil is firm heavy silty clay loam that is about 5 inches thick. The lower part of the subsoil is very firm silty clay. The Tully soils are well drained; permeability is slow.

Ivan soils occur on flood plains. They make up 8 percent of the association. Kahola, Irwin, Olpe, Smolan, Clime, and Sogn soils make up the remaining 12 percent of the association.

Most of this association is cultivated. A few areas on low bottoms are in native timber, and some sloping areas are in tame pasture. All of the common crops are suited, except in upland areas, where corn is not well suited because the soils are droughty. Ivan soils are seldom planted to small grains because of the flooding hazard. A few of the sloping areas are eroded. Most of the farmers raise grain and beef cattle. Crops respond well to fertilizer and conservation practices (fig. 5).

Good gravel roads serve most areas, and the roads parallel the stream valley. Roads that cross stream valleys run along about a third of the section lines.

4. Chase-Osage association

Nearly level, deep soils that have a subsoil of silty clay; on flood plains and low terraces

This association (fig. 6, p. 6) consists of 29,700 acres, or about 6 percent of the county.

Chase soils make up about 30 percent of the association; Osage soils, about 25 percent; and minor soils make up the rest. These soils formed in clayey alluvium.

Chase soils have a surface layer of dark grayish-brown silty clay loam about 14 inches thick. The upper part of the subsoil is firm, heavy silty clay loam about 6 inches thick. The lower part is very firm silty clay about 26 inches thick. These soils are moderately well drained to somewhat poorly drained. Permeability is slow. The soils are on nearly level benches that are seldom flooded.

Osage soils have a surface layer of very dark gray silty clay about 21 inches thick. The subsoil is extremely firm silty clay. The soils are poorly drained. Permeability is very slow. The soils are nearly level and are on depressional bottom lands.

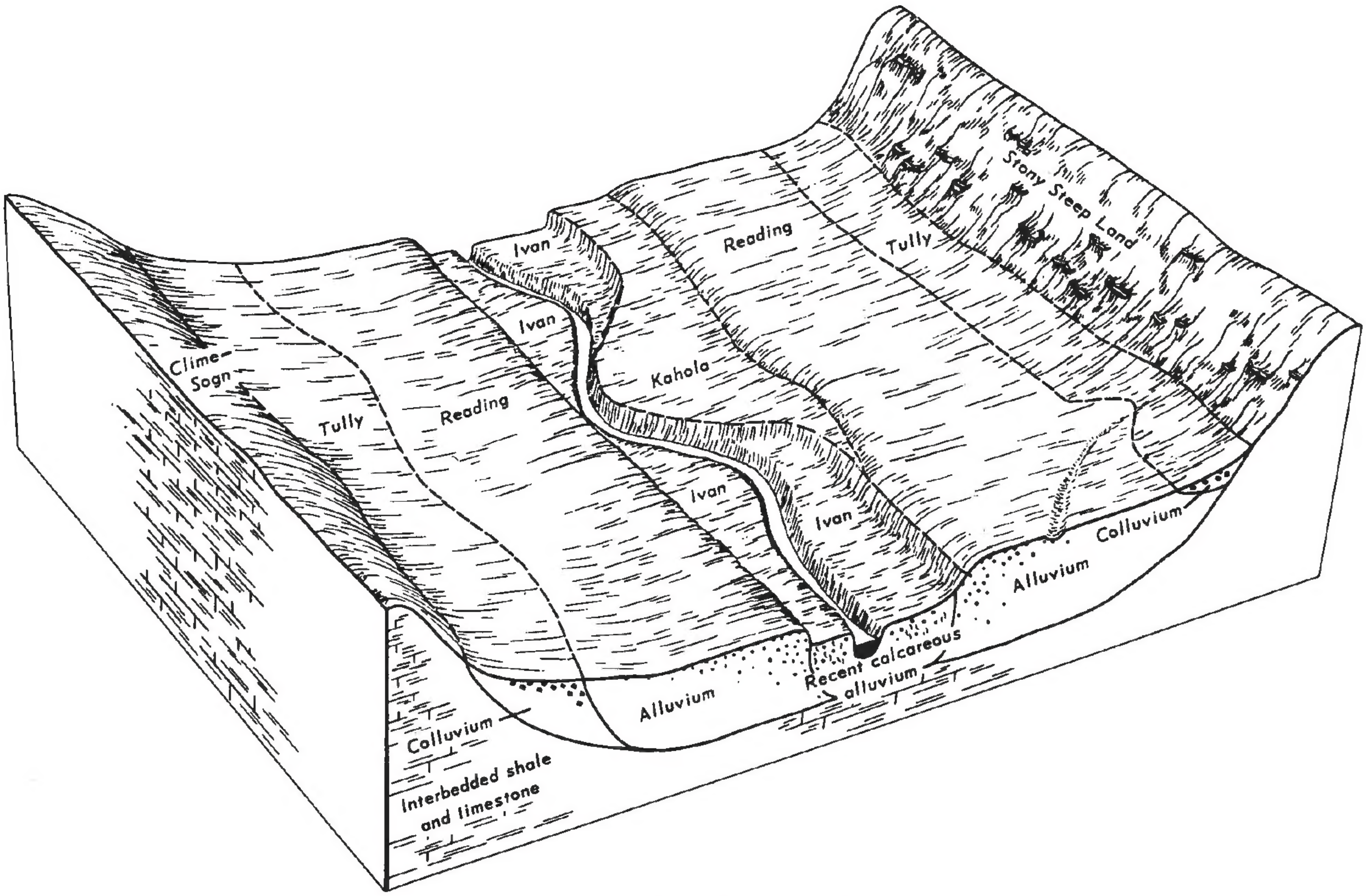


Figure 4.—**Pattern of soils in the Reading-Tully association.**

Figure 5.—**An area of the South Fork Cottonwood River valley. Soils of the Clime-Sogn complex are in the foreground; Tully and Reading soils are in the cultivated areas; and an Ivan soil is in the timbered area.**

Reading soils, which make up 24 percent of the association, are well drained. They occur next to Chase soils. Ivan soils occur on flood plains. They make up 8 percent of the association. Solomon and Kahola soils make up the remaining 13 percent of the association.

Most of this association is cultivated. Generally, all of the common crops are suited. Corn is not well suited to Osage and Solomon soils, because of wetness. Ivan soils are seldom planted to small grains because of the flooding hazard. Many farmers raise silage to sell to cattle feeders.

Good gravel roads run along most section lines.

5. Clime-Sogn association

Gently sloping to steep, moderately deep soils that have a subsoil of silty clay, and shallow silty clay loams; on uplands

This association (fig. 7, p. 7) consists of 100,070 acres, or about 20 percent of the county. Most of the association is strongly sloping, but there are some gently sloping areas on ridgetops and some steep, stony areas along drainageways.

Clime soils make up about 45 percent of the association; Sogn soils, about 15 percent; and minor soils make up the rest. These soils formed over limestone and calcareous shale.

Clime soils have a surface layer of calcareous, dark

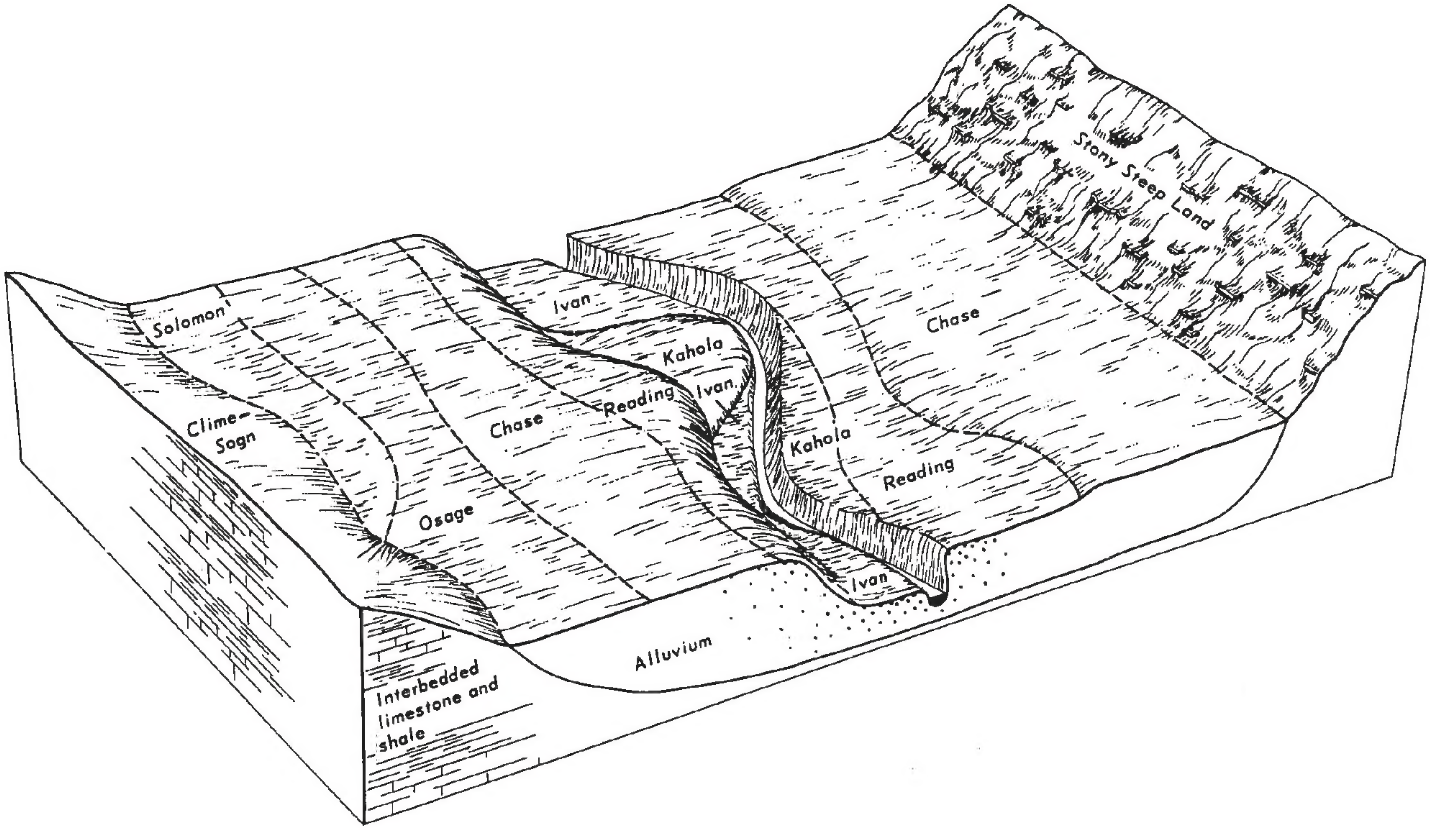


***Figure 6.*—Pattern of soils in the Chase-Osage association.**

grayish-brown silty clay about 9 inches thick. The next layer is very firm, calcareous silty clay about 9 inches thick. The underlying material is silty clay. Unweathered shale occurs at depths of 20 to 40 inches. The soils are moderately well drained to well drained. Permeability is moderately slow.

Sogn soils have a surface layer of dark grayish-brown silty clay loam, about 6 inches thick, overlying limestone. These soils are somewhat excessively drained. Permeability is moderate.

Zaar soils make up 10 percent of the association. These are gently sloping to sloping soils below limestone outcrops. Martin soils, which make up 5 percent of the association, are downslope from shallow and rocky soils. Dwight soils make up 10 percent of the association. They have a thin surface layer over a subsoil of dense silty clay. The rest of the association consists of Tully, Irwin, and Reading soils and of Alluvial land and Stony steep land.

Practically all of the association is in native range. A few small fields on creek bottoms are cultivated. The raising of beef cattle is the main farm enterprise. Cattle are grazed in summer for 4 or 5 months, and after the grazing season are shipped to markets and feedlots.

There are few roads, other than trails, in this association.

6. Ladysmith-Martin association

Nearly level to sloping, deep soils that have a subsoil of silty clay; on uplands

This association consists of 24,780 acres, or about 5 percent of the county. Most of the association is gently sloping to sloping, but there are some steep, rocky slopes along drainageways.

Ladysmith soils make up about 25 percent of the association; Martin soils, about 20 percent; and minor soils make up the rest. These soils formed in clayey sediments or material weathered from shale.

Ladysmith soils have a surface layer of dark-gray light silty clay loam about 9 inches thick. The subsoil is very firm silty clay about 28 inches thick. The soils are moderately well drained to somewhat poorly drained. Permeability is very slow.

Martin soils have a surface layer of very dark gray silty clay loam about 9 inches thick. The transitional layer to the subsoil is firm, heavy silty clay loam about 6 inches thick. The subsoil is very firm silty clay. The soils are moderately well drained. Permeability is slow.

Sogn soils make up 5 percent of the association. They are not suitable for cultivation, because they are shallow and rocky. Irwin soils make up 15 percent of the association. They occur in sloping areas next to Ladysmith soils. They have a subsoil of very firm silty clay. Clime and Zaar soils make up 15 percent of the association.

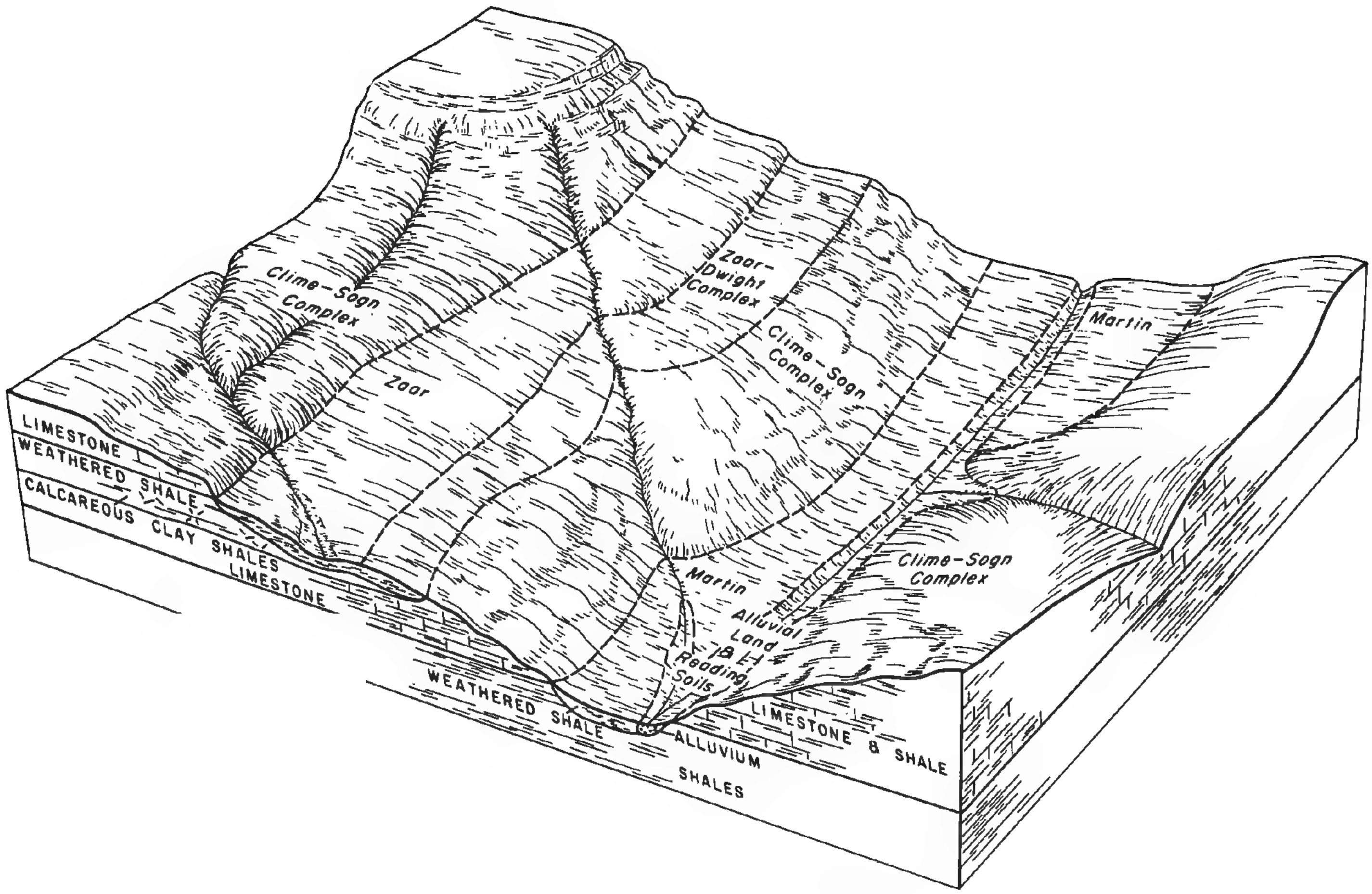


Figure 7.—**Pattern of soils in the Clime-Sogn association.**

They occur in close association with the Sogn soils. Labette soils, which make up about 10 percent of the association, occur on the gentle slopes just above the limestone outcrops. Dwight, Olpe, Reading, and Tully soils make up the remaining 10 percent of the association.

About half of the association is cultivated, and the rest is used for range. Small grains and beef cattle are raised on most farms in the association. The soils are eroded in many of the cultivated areas, and many of the areas are reverting to natural vegetation. Crops respond well to fertilizer.

Good gravel roads run along about two-thirds of the section lines.

Descriptions of the Soils

This section describes the soil series and mapping units of Chase County. The approximate acreage and proportionate extent of the soils are given in table 1.

In the pages that follow, a general description of each soil series is given. Each series description has a short narrative description of a representative profile and a much more detailed description of the same profile, from which highly technical interpretations can be made. Following the profile is a brief statement of the range in characteristics of the soils in the series, as mapped in this county. Some of the nearby or similar soils are named and compared with the soils in the series being compared.

Following the series description, each mapping unit in the series is described individually. For full information on any one mapping unit, it is necessary to read the description of the soil series, as well as the description of the mapping unit. Miscellaneous land types, such as Stony steep land, are described in alphabetic order along with other mapping units.

After the name of each mapping unit there is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. At the end of the description of each mapping unit are listed the capability unit, the range site, the woodland suitability group, and the windbreak suitability group in which the mapping unit has been placed. The pages where some of these groups are described can be readily learned by referring to the "Guide to Mapping Units."

Unless otherwise stated, colors are for dry soil.

For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils are described. Many

of the terms used in the soil descriptions and in other parts of the survey are defined in the Glossary.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent
	Acres	*Percent*
Alluvial land and Reading soils	17, 400	3. 5
Chase silty clay loam	9, 100	1. 8
Clime-Sogn complex	93, 000	18. 8
Dwight silt loam, 1 to 3 percent slopes	21, 750	4. 4
Florence-Labette complex	37, 250	7. 5
Florence-Matfield cherty silt loams	33, 750	6. 8
Irwin silty clay loam, 1 to 3 percent slopes	26, 000	5. 3
Irwin silty clay loam, 1 to 3 percent slopes, eroded	8, 900	1. 8
Irwin silty clay loam, 3 to 5 percent slopes	3, 450	. 7
Irwin silty clay loam, 3 to 5 percent slopes, eroded	3, 450	. 7
Ivan silt loam	7, 400	1. 5
Kahola silt loam	3, 100	. 6
Labette silty clay loam, 1 to 3 percent slopes	11, 100	2. 2
Labette silty clay loam, 3 to 5 percent slopes	1, 960	. 4
Labette silty clay loam, 2 to 5 percent slopes, eroded	1, 800	. 4
Labette-Dwight complex, 1 to 3 percent slopes	28, 250	5. 7
Labette-Sogn complex	57, 500	11. 6
Ladysmith silty clay loam, 0 to 1 percent slopes	1, 300	. 3
Ladysmith silty clay loam, 1 to 3 percent slopes	4, 400	. 9
Ladysmith silty clay loam, 1 to 3 percent slopes, eroded	1, 050	. 2
Martin silty clay loam, 2 to 6 percent slopes	6, 700	1. 4
Martin silty clay loam, 2 to 6 percent slopes, eroded	2, 400	. 5
Martin-Gullied land complex	420	. 1
Olpe-Smolan complex	3, 200	. 6
Osage silty clay	8, 000	1. 6
Reading silt loam, 0 to 1 percent slopes	27, 750	5. 6
Reading silt loam, 1 to 3 percent slopes	7, 900	1. 6
Reading soils, 6 to 12 percent slopes, eroded	520	. 1
Smolan silty clay loam, 2 to 6 percent slopes	1, 150	. 2
Solomon silty clay	1, 600	. 3
Stony steep land	4, 760	1. 0
Tully silty clay loam, 3 to 7 percent slopes	11, 200	2. 3
Tully silty clay loam, 3 to 7 percent slopes, eroded	5, 600	1. 1
Tully cherty silty clay loam, 5 to 15 percent slopes	31, 750	6. 4
Zaar silty clay, 3 to 7 percent slopes	2, 350	. 5
Zaar-Dwight complex, 1 to 3 percent slopes	6, 100	1. 2
Water areas, streams, lakes	2, 050	. 4
Total	495, 360	100. 0

Alluvial Land

Alluvial land consists of deep soils that are frequently flooded. These soils are in narrow upland drainageways. The texture ranges from gravelly silt loam to silty clay. In places the soil is very gravelly and contains some rock. The texture and character of the profile is subject to change with each flooding.

In this county Alluvial land is mapped only with Reading soils.

Alluvial land and Reading soils (0 to 3 percent slopes) (Ar).—This unit consists of frequently flooded soils in narrow upland drainageways. Alluvial land ranges in texture from gravelly silt loam to silty clay. Silty clay loam is the dominant texture. Alluvial land makes up about 80 percent of the unit, and Reading soils, about 20 percent. The Reading soils are at slightly higher elevations along bends of streams.

Nearly all of this unit is used for range. Tall grasses are native to the site. In some places the soil areas are large enough to be used for forage crops or to be planted to bromegrass.

Good range management includes controlling weeds and stocking livestock at a proper rate. (Capability unit VIw-1, Loamy Lowland range site, and windbreak suitability group A)

Chase Series

The Chase series consists of deep, somewhat poorly drained to moderately well drained soils. These soils formed in fine-textured alluvium. They are on low stream terraces and are occasionally flooded. The slope range is 0 to 2 percent.

In a representative profile, the surface layer is dark grayish-brown silty clay loam about 14 inches thick. The upper part of the subsoil is firm, dark-gray heavy silty clay loam about 6 inches thick. The lower part is very firm, dark-gray silty clay about 26 inches thick. The substratum is grayish-brown silty clay. It is mottled with shades of brown and yellow.

Permeability is slow. Fertility is high.

The native vegetation is primarily tall grasses. Most areas are cultivated.

Representative profile of Chase silty clay loam, in a cultivated field, 800 feet south and 800 feet east of the northwest corner of NE¼ sec. 23, T. 20 S., R. 6 E.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak, fine and medium, granular structure; slightly hard when dry, friable when moist; many fine wormholes and worm casts; medium acid; gradual, smooth boundary.

A1—8 to 14 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many fine wormholes and worm casts; medium acid; gradual, smooth boundary.

B1—14 to 20 inches, dark-gray (10YR 4/1) heavy silty clay loam, black (10YR 2/1) when moist; when crushed, dark grayish brown when dry (10YR 4/2) and very dark brown (10YR 2/2) when moist; strong, fine and very fine, subangular blocky structure; hard when dry, firm when moist; few shiny surfaces on peds; many fine wormholes and worm casts; medium acid; gradual, smooth boundary.

B21t—20 to 34 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; when crushed, dark grayish brown (10YR 4/2) when dry and very dark brown (10YR 2/2) when moist; moderate, medium and coarse, angular blocky structure parting to very fine blocky when moist; very hard when dry, very firm when moist; shiny surfaces on many ped faces; medium acid; diffuse, smooth boundary.

B22t—34 to 46 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; when crushed, dark grayish brown when dry (10YR 4/2) and very dark brown (10YR 2/2) when moist; moderate, medium, angular blocky surface; very hard when dry, very firm when moist; few, fine, faint mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6); discontinuous clay films on some ped faces; few fine wormholes; slightly acid; gradual, smooth boundary.

C—46 to 60 inches, grayish-brown (10YR 5/2) silty clay, somewhat less clayey than B22t horizon, very dark

grayish brown (10YR 3/2) when moist; massive; very hard when dry, very firm when moist; common, fine, distinct mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6); few, fine, hard, black concretions; very few, small, calcium carbonate concretions; mildly alkaline.

The A horizon ranges from 8 to 20 inches in thickness and from grayish brown to very dark gray in color.

The B1 horizon ranges from 4 to 10 inches in thickness. The B2t horizon ranges from 16 to 32 inches in thickness and is grayish brown to dark gray in color.

The C horizon ranges from dark gray to light yellowish brown in color. The texture is silty clay loam or silty clay.

Reaction ranges from medium to slightly acid in the A horizon, from medium acid to neutral in the B2 horizon, and from slightly acid to mildly alkaline in the C horizon.

Chase soils are finer textured than the associated Reading or Kahola soils. Also, Kahola soils lack a B2t horizon. The Chase soils are better drained and coarser textured than the associated Osage soils.

Chase silty clay loam (0 to 2 percent slopes) (Ch).—This soil is on low stream terraces. The slopes are plane or weakly concave.

Included in mapping were a few small areas of Reading and Osage soils.

The available water capacity is high. Runoff is slow.

Most of this soil is cultivated. It is occasionally flooded, and wetness is a limitation in some years. The major management needs are the maintenance of fertility and the maintenance of good tilth. (Capability unit IIw–2, Loamy Lowland range site, windbreak suitability group A, and woodland suitability group 3)

Clime Series

The Clime series consists of moderately deep, moderately well drained to well drained, calcareous soils on uplands. These soils formed in material weathered from calcareous, clayey shale. The slope range is 3 to 25 percent.

In a representative profile, the surface layer is calcareous, dark grayish-brown silty clay about 9 inches thick. The subsoil is very firm, calcareous, grayish-brown silty clay about 9 inches thick. The underlying material is calcareous, pale-brown silty clay. Shale is at a depth of 33 inches.

Permeability is moderately slow. Fertility is medium.

The native vegetation is mixed tall and mid grasses. Most areas are used for range.

Representative profile of Clime silty clay under a cover of native range, in an area of Clime-Sogn complex, 820 feet west and 1,800 feet south of the northeast corner of sec. 31, T. 18 S., R. 8 E.

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) silty clay, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; hard when dry, firm when moist; many roots; calcareous; moderately alkaline; clear, smooth boundary.

B2—9 to 18 inches, grayish-brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; very hard when dry, very firm when moist; few roots; calcareous; moderately alkaline; clear, smooth boundary.

C1—18 to 33 inches, light brownish-gray (10YR 6/2) silty clay, dark grayish brown (10YR 4/2) when moist; massive; very hard when dry, very firm when moist; many shale fragments; few roots; calcareous; moderately alkaline; diffuse, smooth boundary.

C2—33 inches, light-gray (10YR 7/1) consolidated clay shale; moderately alkaline; calcareous.

The A horizon ranges from 5 to 10 inches in thickness and from dark gray to grayish brown in color. The texture of the A horizon ranges from heavy silty clay loam to silty clay.

The B2 horizon ranges from 6 to 10 inches in thickness and from grayish brown to brown in color.

The C1 horizon ranges from 10 to 20 inches in thickness and from grayish brown to very pale brown in color. In places there are layers of limestone in the C2 horizon.

The depth to shale that has been only slightly altered by soil-forming processes ranges from 20 to 40 inches. Reaction is mildly alkaline to moderately alkaline in all horizons, and depth to free carbonates is less than 8 inches.

Clime soils occur in association with Zaar and Sogn soils. They are deeper over bedrock and more clayey than Sogn soils. They are shallower over bedrock and more alkaline in the A horizon than Zaar soils.

Clime-Sogn complex (3 to 25 percent slopes) (Cs).—This complex is in broad areas on uplands. About 47 percent of the acreage is Clime soils, and 20 percent is Sogn soils. These soils have the profile described as representative of their respective series.

Included in mapping were areas of Zaar, Labette, and Dwight soils.

The available water capacity is low to moderate in Clime soils and low in Sogn soils. Runoff is rapid.

This complex is used for range. Erosion is a limitation on cattle trails and where the grass cover is thin. (Capability unit VIe–2; Clime soils are in Limy Upland range site and windbreak suitability group D; Sogn soils are in Shallow Limy range site and windbreak suitability group G)

Dwight Series

The Dwight series consists of deep, moderately well drained soils on uplands. These soils are on drainage divides. They formed in clay residuum or sediments of similar nature. The slope range is 1 to 3 percent.

In the representative profile, the surface layer is dark grayish-brown silt loam about 5 inches thick (fig. 8). The subsoil is extremely firm silty clay about 37 inches thick. It is dark grayish brown in the upper part, brown in the middle part, and brown mottled with dark grayish-brown, black, and yellowish red in the lower part.

Below the subsoil is cherty limestone.

Permeability is very slow. Fertility is low.

The native vegetation is mostly short and mid prairie grasses. Most areas are used for native range. A few areas are cultivated.

Representative profile of Dwight silt loam, 1 to 3 percent slopes, in native pasture, 3,640 feet east and 2,740 feet south of the northwest corner of sec. 12, T. 22 S., R. 7 E.

A1—0 to 5 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many fine roots; medium acid; abrupt, smooth boundary.

B21t—5 to 21 inches, dark grayish-brown (10YR 4/2) silty clay, very dark brown (10YR 2/2) when moist; organic stains on ped surfaces; moderate, coarse, columnar structure breaking to weak, fine, angular blocky; extremely hard when dry, extremely firm when moist; common fine roots that are flattened; mildly alkaline; diffuse, smooth boundary.

Figure 8.—**Profile of Dwight silt loam.**

B22t—21 to 32 inches, brown (10YR 4/3) silty clay, dark brown (10YR 3/3) when moist; weak, fine, angular blocky structure; extremely hard when dry, extremely firm when moist; few, fine, faint mottles of reddish brown (5YR 5/4) and black stains; few fine chert chips; few fine roots; moderately alkaline; diffuse, smooth boundary.

B3—32 to 42 inches, brown (7.5YR 4/4) silty clay, dark brown (7.5YR 3/3) when moist; weak, fine, angular blocky structure; extremely hard when dry, extremely firm when moist; common, fine, distinct mottles of dark grayish brown (10YR 4/2), black (10YR 2/1), and yellowish red (5YR 5/6); no visible roots; few fine chert chips and shale flecks; moderately alkaline; abrupt boundary.

R—42 inches, cherty limestone.

The A horizon ranges from 2 to 7 inches in thickness and from grayish brown to dark grayish brown in color.

The B2t horizon ranges from 11 to 40 inches in thickness and from very dark grayish brown to brown in color. In places the lower part of the B2t horizon is faintly mottled with shades of red, yellow, and brown. The B3 horizon ranges from 10 to 20 inches in thickness and from brown to yellowish brown in color. In places there are small, black concretions and calcium carbonate concretions in the B3 horizon and in the lower part of the B2t horizon.

The R horizon is shale, limestone, or cherty limestone and begins at a depth of 40 to 60 inches.

Reaction ranges from medium acid to neutral in the A horizon, from slightly acid to moderately alkaline in the B2t horizon, and from neutral to moderately alkaline in the B3 horizon.

Dwight soils have a thinner A horizon and a more abrupt change to the B2t horizon than the associated Irwin or Ladysmith soils.

Dwight silt loam, 1 to 3 percent slopes (Dw).—This soil is gently sloping and is on the drainage divides. The slopes are plane and convex, and the average gradient is 2 percent.

Included in mapping were small areas of Labette and Irwin soils. Also included were a few areas of soils similar to Dwight silt loam, except that depth to rock is 30 to 40 inches. Small eroded areas are shown on the map by a symbol. Each symbol represents an area of about 1 to 4 acres.

The available water capacity is moderate, but the moisture held is very slowly available to plants. This soil is droughty for summer crops. Runoff is medium.

About 80 percent of the acreage is presently in native range. About 20 percent of it is cultivated. The chief management needs in cultivated areas are control of erosion, maintenance of fertility, and maintenance of good tilth. (Capability unit IVe-1, Claypan range site windbreak suitability group E)

Florence Series

The Florence series consists of deep, well-drained soils on uplands. These soils formed in material weathered from cherty limestone and interbedded shale. The slope range is 3 to 15 percent.

In a representative profile the surface layer is dark grayish-brown cherty silt loam about 13 inches thick (fig. 9). The upper part of the subsoil is firm, dark grayish-brown heavy cherty silty clay loam about 7 inches thick. The lower part is very firm, dark reddish-brown coarse cherty clay about 22 inches thick.

Below the subsoil is cherty limestone.

Permeability is moderately slow. Fertility is medium. The native vegetation is primarily tall and mid native grasses. All areas are in native range.

Representative profile of Florence cherty silt loam, in an area of Florence-Matfield cherty silt loams, in native pasture, 3,600 feet east and 900 feet north of the southwest corner of sec. 6, T. 22 S., R. 8 E.

A11—0 to 3 inches, dark grayish-brown (10YR 4/2) cherty silt loam, very dark brown (10YR 2/2) when moist; strong, fine, granular structure; upper 1 inch has weak, thin, platy structure; slightly hard when dry, friable when moist; chert fragments, ¼ inch to 3 inches in diameter, make up about 15 percent of the mass; many roots; medium acid; gradual, smooth boundary.

A12—3 to 13 inches, dark grayish-brown (10YR 4/2) cherty silt loam, very dark brown (10YR 2/2) when moist; strong, fine, granular structure; slightly hard when dry, friable when moist; chert content increases to 80 percent of the mass; few fragments up to 7 inches

Figure 9.—**Profile of Florence cherty silt loam.**

in diameter, but most are less than 3 inches; many roots; few worm casts; medium acid; gradual, smooth boundary.

B1—13 to 20 inches, dark grayish-brown (10YR 4/2) heavy cherty silty clay loam, very dark grayish brown (10YR 3/2) when moist; strong, fine, subangular blocky structure; hard when dry, firm when moist; shiny surfaces on ped faces; plentiful fine roots; most pores are open; few worm casts; chert content about 80 percent; common roots; medium acid; gradual, smooth boundary.

B2t—20 to 42 inches, dark reddish-brown (2.5YR 3/4) coarse cherty clay, dark red (2.5YR 3/5) when moist; strong, fine, angular blocky structure; extremely hard when dry, very firm when moist; chert increases in size (commonly 5 by 8 inches) and makes up about 80 percent of the mass; few open pores; few roots; slightly acid; clear, slightly wavy boundary.

R—42 inches +, cherty limestone with lateral and vertical seams filled with dark-red clay.

The A horizon ranges from 9 to 16 inches in thickness and from dark brown to dark grayish brown in color. The texture of the A1 horizon is cherty silt loam or cherty silty clay loam, but in places the upper few inches is largely free of chert.

The B1 horizon ranges from 3 to 8 inches in thickness and from dark grayish brown to reddish brown in color. The B2t horizon ranges from 15 to 36 inches in thickness and from reddish brown to dark red in color.

In most places the R horizon is cherty limestone, but in some places it is limestone or shale. The soil consists of more than 60 percent chert fragments in all parts, except in the upper part of the A1 horizon.

Reaction in the A11, A12, and B1 horizons ranges from strongly acid to neutral, and the B2t horizon ranges from medium acid to neutral. The lower limit of the range in reaction for all horizons is lower than the range described for the series, but this difference does not alter the usefulness or behavior of the soils.

The A horizon in Florence soils is thinner and darker colored in the lower part than the associated Matfield soils. Florence soils have angular chert in the profile, but the similar Olpe soils have rounded chert pebbles. Florence soils have more chert in the profile than the associated Labette soils.

Florence-Labette complex (2 to 12 percent slopes) (Fa).—This complex is in broad areas on uplands. About 34 percent of the acreage is Labette soils, 47 percent is Florence soils, and less than 20 percent is inclusions of other soils. The Florence soil in this complex has the profile described as representative of the series.

The soils in this complex take in water well and release water readily for plant use. The available water capacity is low in Florence soils and moderate to low in Labette soils. Runoff is medium to rapid, depending on the slope.

These soils are used for range. Erosion is a hazard where the grass cover is thin. (Capability unit VIe–4, Loamy Upland range site; Labette soils are in windbreak suitability group C, and Florence soils are in windbreak suitability group F)

Florence-Matfield cherty silt loams (1 to 15 percent slopes) (Fm).—This unit is on uplands. About 70 percent of the acreage is Florence soils, and 25 percent is Matfield soils. Matfield soils are gently sloping and are on divides, but Florence soils are on the steeper side slopes. Included in mapping were small areas of Dwight and Labette soils.

The soils take in water well and release water readily for plant use. The available water capacity is low. Runoff is slow to rapid, depending on the slope.

These soils are used for range. Erosion is a hazard where the grass cover is thin and sparse. (Capability unit VIe–3; Florence soils are in Loamy Upland range site and windbreak suitability group F; Matfield soils are in Flint Ridge range site and windbreak suitability group G)

Irwin Series

The Irwin series consists of deep, moderately well drained to well drained soils on uplands. These soils formed in material weathered from shale or clayey sediment. The slope range is 1 to 5 percent.

In a representative profile, the surface layer is dark grayish-brown silty clay loam about 11 inches thick. The subsoil is very firm silty clay about 42 inches thick. It is dark grayish brown in the upper part, brown in the

middle part, and light brown in the lower part. The substratum is light-brown to yellowish-brown silty clay and weathered, clayey shale.

Permeability is very slow. Fertility is medium.

The native vegetation is primarily mixed tall and mid grasses. These soils are used for cultivated crops and native range.

Representative profile of Irwin silty clay loam, 1 to 3 percent slopes, in a native pasture, 50 feet south and 50 feet west of northeast corner of NW1/4 sec. 15, T. 22 S., R. 7 E.

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and very fine, granular structure; slightly hard when dry, friable when moist; many fine roots; medium acid; clear, wavy boundary.

A3—9 to 11 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine and very fine, subangular blocky structure; hard when dry, firm when moist; many wormholes and worm casts; few, fine, rounded chert pebbles 1/2 inch across; many fine roots; slightly acid; clear, wavy boundary.

B21t—11 to 26 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, angular blocky structure, parting to weak, fine, angular blocky; extremely hard when dry, very firm when moist; medium, distinct clay films coat peds and bridge many pores; few, fine, faint mottles of strong brown and a few black specks; few flattened roots; neutral; diffuse, smooth boundary.

B22t—26 to 38 inches, brown (7.5YR 5/3) silty clay, dark brown (7.5YR 4/3) when moist; weak, coarse, angular blocky structure; extremely hard when dry, very firm when moist; thin, patchy, discontinuous clay films; few, fine, faint mottles of strong brown; few roots; few fine chert chips; mildly alkaline; diffuse, smooth boundary.

B3—38 to 53 inches, light-brown (7.5YR 6/3) silty clay, dark brown (7.5YR 4/4) when moist; weak, coarse, angular blocky structure parting to weak, fine, angular blocky; extremely hard when dry, very firm when moist; few calcium carbonate concretions; few, fine, rounded chert chips; moderately alkaline; gradual, wavy boundary.

C—53 to 60 inches, mixture of light-brown (7.5YR 6/3) silty clay and yellowish-brown (10YR 5/6) clay shale; the weathered shale has weak platy structure; the silty clay is massive and is extremely hard when dry and very firm when moist; moderately alkaline.

The A1 horizon ranges from 5 to 12 inches in thickness, except in the eroded soils, and from grayish brown to dark grayish brown in color. The texture is mostly light silty clay loam but ranges from heavy silt loam to silty clay loam. The A3 horizon ranges from 1 to 4 inches in thickness and from grayish brown to very dark grayish brown in color.

The B2t horizon ranges from 20 to 34 inches in thickness; it is brown to dark grayish brown in color. In places the upper part of the B2t horizon is free of mottles. The B3 horizon ranges from 6 to 20 inches in thickness.

The C horizon ranges from pale brown to reddish brown in color. Shale and limestone fragments range from none to about half the volume of the C horizon.

Reaction ranges from medium acid to neutral in the A horizon, from medium acid to mildly alkaline in the B2t horizon, and from mildly alkaline to moderately alkaline in the C horizon.

In the eroded soils, the A1 horizon is thinner than is defined as the range for the series.

Irwin soils are browner in the B2t horizon and finer textured in the C horizon than are the similar Ladysmith soils. The A1 horizon and the transitional layer to the B2t horizon is thicker in these soils than in the associated Dwight soils. The transitional layer from the A1 horizon to the B2t horizon is thinner than in the associated Tully and Smolan soils, and the B2t horizon is more clayey. The transitional horizon from the A1 horizon to the B2t horizon is thinner than in the associated Labette soils, and the depth to bedrock is greater.

Irwin silty clay loam, 1 to 3 percent slopes (Ic).—This soil has the profile described as representative for the series. It occurs on broad drainage divides. The slopes are plane or convex, and the average gradient is 2 percent.

Included in mapping were small areas of Ladysmith, Labette, and Dwight soils. Also included were a few areas of eroded Irwin soils. These areas are about 1 to 4 acres in size.

The available water capacity is high, but the moisture held in the clayey subsoil is slowly available to plants. Runoff is medium.

About 40 percent of the acreage is cultivated, and about 60 percent is used for native range. In cultivated areas the main management need is the control of erosion. (Capability unit IIIe–1, Clay Upland range site, windbreak suitability group C)

Irwin silty clay loam, 1 to 3 percent slopes, eroded (In).—The surface layer of this soil has been thinned by erosion, but the profile is otherwise like that described as representative for the series. The surface layer is about 3 to 5 inches thick. The plow layer is more clayey than that of the uneroded soils. In about 75 percent of the acreage, the surface layer is brownish heavy silty clay loam.

This soil occurs on broad drainage divides. In many places distinct, shallow gullies have formed. The slopes are plane and convex. The average gradient is 2 percent.

Included in mapping were minor areas of Dwight soils.

The available water capacity is high, but the moisture held in the clayey subsoil is slowly available to plants. Runoff is rapid.

About 90 percent of the acreage is cultivated, and the rest is in range. In cultivated areas the main management need is to control erosion, to maintain or improve fertility, and to maintain good tilth. (Capability unit IIIe–6, Claypan range site, windbreak suitability group E)

Irwin silty clay loam, 3 to 5 percent slopes (Ir).—This soil occurs mostly on foot slopes. The slopes are plane and convex; the average gradient is 4 percent.

Included in mapping were small areas of Tully soils. Also included were small areas of eroded Irwin soils. These areas are about 1 to 4 acres in size.

The available water capacity is high, but the moisture held in the clayey subsoil is slowly available to plants. Runoff is medium.

Most of the acreage is in native range. The chief management needs in cultivated areas are control of erosion, maintaining or improving fertility, and maintaining good tilth. (Capability unit IIIe–5, Clay Upland range site, windbreak suitability group C)

Irwin silty clay loam, 3 to 5 percent slopes, eroded (Is).—The surface layer of this soil has been thinned by erosion, but the profile is otherwise like that described as representative for the series. The surface layer is about 3 to 5 inches thick. The plow layer is more clayey than that of uneroded soils. In about 75 percent of the

acreage, the surface layer is brownish heavy silty clay loam.

This soil is mainly on foot slopes. The slopes are plane and convex. The average gradient is 4 percent.

Included in mapping were minor areas of Tully soils.

The available water capacity is high, but the moisture held in the clayey subsoil is slowly available to plants. Runoff is rapid.

Much of the acreage is cultivated. Some areas that were formerly cultivated have been allowed to reseed naturally and are used for grazing. In cultivated areas the main management need is control of erosion, maintenance of fertility, and maintenance of good tilth. (Capability unit IVe-2, Claypan range site, windbreak suitability group E)

Ivan Series

The Ivan series consists of deep, well drained to moderately well drained soils. These soils occur on the flood plains of stream valleys and are frequently flooded. They formed in silty alluvium. The slope range is 0 to 2 percent.

In a representative profile the surface layer is calcareous, dark grayish-brown silt loam about 17 inches thick. The next layer is friable, calcareous, grayish-brown silt loam about 15 inches thick. The substratum is calcareous, grayish-brown silt loam.

Permeability is moderate. The water table is normally below 8 feet but is nearer the surface during flooding. Fertility is high.

The native vegetation is primarily hardwoods and an understory of tall native grasses. About one-fourth of the acreage is in native vegetation. The rest is cultivated.

Representative profile of Ivan silt loam, in a cultivated field, 3,300 feet west and 40 feet north of the southeast corner of sec. 25, T. 19 S., R. 8 E.

Ap—0 to 9 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; weak, thin, platy structure in upper one inch and the rest of the horizon has weak, fine, granular structure; slightly hard when dry, friable when moist; many worm casts; calcareous; abrupt, smooth boundary.

A1—9 to 17 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; many fine wormholes and worm casts; calcareous, moderately alkaline; gradual, smooth boundary.

AC—17 to 32 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many fine wormholes; thinly stratified with dark grayish-brown (10YR 4/2) lenses of silty clay loam; calcareous, moderately alkaline; gradual, smooth boundary.

C—32 to 60 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, friable when moist; few layers of grayish brown (10YR 5/2) loam; calcareous, moderately alkaline.

The A horizon ranges from 12 to 25 inches in thickness and is very dark gray to grayish brown in color. The texture is mostly silt loam but it ranges from silt loam to silty clay loam. The AC horizon ranges from 12 to 25 inches in thickness and from dark gray to brown in color. The texture is mostly silt loam, but it ranges from silt loam to silty clay loam.

The C horizon ranges from dark gray to brown. The texture is loam to silty clay loam.

Reaction of the A horizon ranges from mildly alkaline to moderately alkaline. In most places Ivan soils are calcareous in all horizons, but in some places they are noncalcareous to a depth of 10 inches.

Ivan soils have free carbonates in the A horizon, unlike the associated Kahola soils. They are less clayey and more alkaline than the associated Reading soils.

Ivan silt loam (0 to 2 percent slopes) (Iv).—This soil is on flood plains. The slopes are plane and weakly concave.

Included in mapping were a few small areas of Kahola and Reading soils.

The available water capacity is high. Runoff is slow.

About 75 percent of the soil is cultivated, and the rest is in native vegetation. In cultivated areas the main limitation is erosion and damage to crops that comes from frequent flooding. (Capability unit IIw-1, Loamy Lowland range site, windbreak suitability group A, woodland suitability group 1)

Kahola Series

The Kahola series consists of deep, well-drained soils on low stream terraces. These soils formed in silty alluvium. They are occasionally flooded, but floodwaters seldom damage the crops or the soils. The slope range is 0 to 2 percent.

In a representative profile, the surface layer is heavy silt loam about 17 inches thick. It is dark gray in the upper 12 inches and dark grayish brown in the lower 5 inches. The next layer is friable, grayish-brown light silty clay loam about 8 inches thick. The substratum is calcareous, grayish-brown silt loam and loam.

Permeability is moderate. The water table is normally at a depth below 8 feet. Fertility is high.

The native vegetation is primarily tall native grasses. There are a few oaks and other trees. Most areas are in cultivation.

Representative profile of Kahola silt loam, in a cultivated area, 440 feet south and 1,700 feet east of the northwest corner of sec. 6, T. 21 S., R. 6 E.

Ap—0 to 7 inches, dark-gray (10YR 4/1) heavy silt loam, very dark brown (10YR 2/2) when moist; weak, very fine, granular structure; slightly hard when dry, friable when moist; neutral; abrupt, smooth boundary.

A11—7 to 12 inches, dark-gray (10YR 4/1) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; many fine wormholes and worm casts; neutral; clear, smooth boundary.

A12—12 to 17 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; many wormholes and worm casts; neutral; clear, wavy boundary.

AC—17 to 25 inches, grayish-brown (10YR 5/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many wormholes and worm casts; moderately alkaline; diffuse, smooth boundary.

C1—25 to 35 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; stratified with few layers of silty clay loam; massive; slightly hard when dry, friable when moist; few wormholes and worm casts; calcareous, moderately alkaline; diffuse, smooth boundary.

C2—35 to 52 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; massive; has a few layers of silt loam, sandy loam, and silty clay loam; soft when dry, friable when moist; strongly calcareous; moderately alkaline; diffuse, wavy boundary.

C3—52 to 60 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; massive; has many layers of silt loam, sandy loam, and silty clay loam; soft when dry, friable when moist; strongly calcareous, moderately alkaline.

The A horizon ranges from 15 to 30 inches in thickness and from dark gray to grayish brown in color. The texture of the A horizon is mostly silt loam, but in places it is light silty clay loam. The AC horizon ranges from 5 to 15 inches in thickness and is dark gray to grayish brown in color. The texture of the AC horizon ranges from heavy silt loam to light silty clay loam.

The C horizon ranges from pale brown to dark gray. The texture is sandy loam to silty clay loam. In places the texture is silty clay at a depth below 3 feet.

Reaction ranges from slightly acid to mildly alkaline in the A horizon, from neutral to moderately alkaline in the AC horizon, and from mildly alkaline to moderately alkaline in the C horizon. The depth to free carbonates is 15 to 40 inches.

Kahola soils lack free carbonates in the A horizon, unlike the associated Ivan soils. They are coarser textured than the associated Reading and Chase soils and lack the B2t horizon of those soils.

Kahola silt loam (0 to 2 percent slopes) (Ko).—This soil is on low stream terraces. The slopes are plane and weakly concave.

Included in mapping were a few small areas of Ivan and Reading soils.

The available water capacity is high. This soil takes in water readily, and stored water is readily available to plants. Runoff is slow.

Most of this soil is cultivated. The chief management needs are maintaining fertility and good tilth. (Capability unit I-1, Loamy Lowland range site, woodland suitability group 3, windbreak suitability group A)

Labette Series

The Labette series consists of moderately deep, well-drained soils on uplands. These soils formed in material weathered from limestone and shale. The slope range is 1 to 12 percent.

In a representative profile, the surface layer is dark grayish-brown silty clay loam about 10 inches thick. The upper part of the subsoil is firm, brown heavy silty clay loam about 5 inches thick. The lower part is firm, reddish-brown silty clay about 19 inches thick. The underlying material is reddish-brown silty clay and yellowish-brown clay shale. Limestone is at a depth of 38 inches.

Permeability is slow. Fertility is medium.

The native vegetation is mixed tall and mid grasses. About 20 percent of the acreage is cultivated, and about 80 percent is used for native range.

Representative profile of Labette silty clay loam, 1 to 3 percent slopes, under a cover of native range 924 feet west and 50 feet north of the southeast corner of sec. 1, T. 22 S., R. 6 E.

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; strong, fine and medium, granular structure; slightly hard when dry, friable when moist; few open pores; many fine roots; slightly acid; gradual, smooth boundary.

B1—10 to 15 inches, brown (7.5YR 4/2) heavy silty clay loam, dark brown (7.5YR 3/2) when moist; strong, fine and very fine, subangular blocky structure; hard when dry, firm when moist; few thin patchy clay films; many open pores; many fine roots; slightly acid; gradual, smooth boundary.

B2t—15 to 34 inches, reddish-brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) when moist; moderate, medium, angular blocky structure when dry; moderate, very fine, angular blocky structure that has a subangular blocky component when moist; very hard when dry, firm when moist; few fine pores partly filled with clay flow; medium clay films cover nearly all ped faces; many fine roots; slightly acid; gradual, wavy boundary.

C—34 to 38 inches, mixture of about one-third reddish-brown (5YR 5/3) silty clay, dark reddish brown (5YR 3/3) when moist; two-thirds is yellowish-brown (10YR 5/6), weathered, noncalcareous clay shale; massive; very hard when dry, firm when moist; weak, thin, patchy clay films on redder part; few roots; mildly alkaline; abrupt, wavy boundary.

R—38 inches, hard, jointed limestone with little displacement of large fragments.

The A horizon ranges from 6 to 12 inches in thickness, except in the eroded phase, and from very dark gray to grayish brown in color.

The B1 horizon ranges from 4 to 8 inches in thickness and from brown to grayish brown in color. The B2t horizon ranges from 8 to 22 inches in thickness and from dark brown to reddish brown in color.

The C horizon ranges from 2 to 20 inches in thickness.

The R horizon is limestone, cherty limestone, and in places, calcareous shale.

The Labette soils are 20 to 40 inches deep over bedrock.

Reaction ranges from medium acid to slightly acid in the A1 and B1 horizons, from medium acid to neutral in the upper part of the B2t horizon and from slightly acid to mildly alkaline in the lower part of the B2t horizon, and from mildly to moderately alkaline in the C horizon.

In the eroded soils, the A horizon is thinner than is defined as the range for the series.

Labette soils have a thicker transitional layer from the A1 horizon to the B2t horizon and are shallower to bedrock than the associated Irwin series. The Labette soils are shallower to bedrock than the associated Tully, Smolan, and Martin soils. Labette soils have less chert in the profile than the associated Florence soils.

Labette silty clay loam, 1 to 3 percent slopes (La).—This soil has the profile described as representative for the series. It is on drainage divides. The slopes are plane and convex, and the average gradient is 2 percent.

Included in mapping were some small areas of Irwin and Dwight soils. Also included were a few areas of eroded Labette soils. These areas are about 1 to 4 acres in size.

The available water capacity is moderate to low. The soil takes in water well and releases it readily to plants. Runoff is medium.

About 30 percent of the acreage is presently being tilled, and the rest is used for native range. In cultivated areas the main management need is the control of erosion. (Capability unit IIe-1, Loamy Upland range site, windbreak suitability group C)

Labette silty clay loam, 3 to 5 percent slopes (Lb).—This soil is on drainage divides. The slopes are plane and convex, and the average gradient is 4 percent.

Included in mapping were some small areas of Irwin and Dwight soils. Also included were a few areas of eroded Labette soils. These areas are about 1 to 4 acres in size.

The available water capacity is moderate to low. The soil takes in water well and releases it readily to plants. Runoff is medium to rapid.

About 10 percent of the acreage is presently being tilled, and the rest is used for range. In cultivated areas the main management need is the control of erosion. (Capability unit IIIe-3, Loamy Upland range site, windbreak suitability group C)

Labette silty clay loam, 2 to 5 percent slopes, eroded (Lc).—The surface layer of this soil has been thinned by erosion, but the profile is otherwise like that described as representative for the series. The surface layer is about 3 to 6 inches thick. The plow layer is more clayey than that of the uneroded soils. In about 75 percent of the acreage, the surface layer is heavy silty clay loam. This soil occurs on upland divides. The slopes are plane and convex, and the average gradient is 4 percent.

Included in mapping were minor areas of Dwight and Irwin soils.

The available water capacity is moderate to low. Runoff is rapid.

Most of the acreage is cultivated, but some areas are in abandoned cropland. In cultivated areas the main management needs are the control of erosion, the maintenance of fertility, and the maintenance of good tilth. (Capability unit IIIe-7, Clay Upland range site, windbreak suitability group C)

Labette-Dwight complex, 1 to 3 percent slopes (Ld).—This complex is in broad upland divides. About 50 percent of the acreage is Labette soils, 41 percent is Dwight soils, and 9 percent is other soils.

Included in mapping were small areas of Irwin, Zaar, and Ladysmith soils.

The available water capacity is moderate in Dwight soils. The available water capacity is moderate to low in Labette soils. Dwight soils release water slowly for plant use; Labette soils release water readily. Runoff is medium.

About 80 percent of the acreage is used for range, and 20 percent is used for crops. In cultivated areas the main management need is the control of erosion. (Capability unit IIIe-2; Labette soils are in Loamy Upland range site and windbreak suitability group C; Dwight soils are in Claypan range site and windbreak suitability group E)

Labette-Sogn complex (2 to 12 percent slopes) (Le).—This complex is in broad areas of uplands. About 38 percent of the acreage is Sogn soils, and 47 percent is Labette soils.

Included in mapping were areas of Florence and Dwight soils.

The available water capacity is moderate to low in Labette soils; it is low in Sogn soils. Water is released readily for plant use. Runoff is medium to rapid.

This complex is used for range. Erosion is a limitation where grass cover is thin. (Capability unit VIe-3; Labette soils are in Loamy Upland range site and windbreak suitability group C; Sogn soils are in Shallow Limy range site and windbreak suitability group G)

Ladysmith Series

The Ladysmith series consists of deep, moderately well drained to somewhat poorly drained soils on uplands. These soils formed in mottled clayey sediment. The slope range is 0 to 3 percent.

In a representative profile, the surface layer is dark-gray light silty clay loam about 9 inches thick. The subsoil is very firm silty clay about 28 inches thick. It is dark gray in the upper part, dark grayish brown in the middle part, and grayish brown in the lower part. The substratum is light brownish-gray silty clay loam. It is mottled with yellowish brown and strong brown.

Permeability is very slow. Fertility is medium.

The native vegetation is primarily mixed tall and mid grasses. About half of the areas are cultivated, and the rest is used for native range.

Representative profile of Ladysmith silty clay loam, 0 to 1 percent slopes, in native pasture, 1,320 feet north and 600 feet west of the southeast corner of sec. 9, T. 19 S., R. 9 E:

A1—0 to 9 inches, dark-gray (10YR 4/1) light silty clay loam, black (10YR 2/1) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many roots; medium acid; clear, smooth boundary.

B21t—9 to 24 inches, dark-gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; weak, coarse, prismatic structure that parts to moderate, medium and fine, angular blocky; very hard when dry, very firm when moist; few lighter colored thin coats on ped faces; some shiny surfaces, possibly clay films; common fine roots; slightly acid; gradual, smooth boundary.

B22t—24 to 32 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak, medium, angular blocky structure; very hard when dry, very firm when moist; few flattened roots; mildly alkaline; gradual, smooth boundary.

B3—32 to 37 inches, grayish-brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; common, fine, distinct mottles of yellowish brown (10YR 5/6); weak, medium, angular blocky structure; very hard when dry, firm when moist; few small calcium carbonate concretions; moderately alkaline but noncalcareous; gradual, smooth boundary.

C1—37 to 54 inches, light brownish-gray (10YR 6/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; many, fine and medium, distinct mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6); massive; hard when dry, firm when moist; few, small, hard, black concretions; moderately alkaline but noncalcareous; diffuse, smooth boundary.

C2—54 to 60 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; many, medium and coarse, distinct mottles of yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6); few mottles are dark gray (10YR 4/1); massive; very hard when dry, firm when moist; few, small, hard, black concretions; moderately alkaline but noncalcareous.

The A horizon ranges from 6 to 12 inches in thickness, except in the eroded phase, and from dark gray to gray in color. The texture of the A horizon is mostly light silty clay loam but ranges from heavy silt loam to silty clay loam.

The B21t horizon ranges from 10 to 16 inches in thickness and from dark gray to grayish brown in color. Structure is mostly angular blocky, but in a few places, the upper 2 inches is subangular blocky and heavy silty clay loam.

The B22t horizon ranges from 8 to 20 inches in thickness and from grayish brown to dark gray in color. In a few places the B22t horizon is faintly mottled.

The B3 horizon ranges from 6 to 20 inches in thickness and from grayish brown to light gray. Texture ranges from silty clay loam to silty clay.

The C horizon ranges from grayish brown to light gray. Texture ranges from silty clay loam to silty clay. In some

places at depths below 40 inches the C horizon rests on soft, weathered, clayey shale or shale interbedded with limestone.

Reaction ranges from medium acid to neutral in the A and B21t horizons, from slightly acid to mildly alkaline in the B22t horizon, and from neutral to moderately alkaline in the B3 and C horizons.

In the eroded soils, the A1 horizon is thinner than is defined as the range for the series.

Ladysmith soils have a grayer B2t horizon and a coarser textured C horizon than the similar Irwin soils. They have a thicker A horizon and a thicker transitional layer to the B2t horizon than the associated Dwight soils. Ladysmith soils have a thinner transitional layer from the A horizon to the B2t horizon and have a grayer B2t horizon than the associated Martin soils.

Ladysmith silty clay loam, 0 to 1 percent slopes (Lm).—This soil has the profile described as representative for the series. It is on broad divides. The slope gradient is less than 1 percent; in most places it is about 0.5 percent.

Included in mapping were some small areas of Dwight and Irwin soils.

The available water capacity is high, but the moisture held is slowly available to plants. Runoff is slow.

About 50 percent of the acreage is cultivated, and the rest is used for native range. In cultivated areas the main limitation is the slow movement of water in the subsoil. This causes the soil to be droughty in dry periods and wet when rainfall is high. (Capability unit IIs–1, Clay Upland range site, windbreak suitability group C)

Ladysmith silty clay loam, 1 to 3 percent slopes (Lo).—This soil is on drainage divides. The slopes are plane and convex, and the average gradient is about 1.5 percent.

Included in mapping were some small areas of Irwin and Dwight soils. Also included were a few areas of eroded Ladysmith soils. These eroded areas are shown on the map by a spot symbol. Each symbol represents an area about 1 to 4 acres in size.

The available water capacity is high, but the moisture held in the clayey subsoil is slowly available to plants. Runoff is medium.

About 50 percent of the acreage is cultivated, and the rest is used for native range. In cultivated areas the main management need is control of erosion. (Capability unit IIIe–1, Clay Upland range site, windbreak suitability group C)

Ladysmith silty clay loam, 1 to 3 percent slopes, eroded (Ls).—The profile of this soil is similar to that described for the series, except that the surface layer has been thinned by erosion. The plow layer is more clayey than in the uneroded soil. The surface layer is about 3 to 6 inches thick. In about 75 percent of the acreage, the surface layer is dark-gray heavy silty clay loam. This soil occurs on upland drainage divides. The slopes are plane or convex, and the average gradient is 2 percent.

Included in mapping were minor areas of Dwight and Irwin soils.

The available water capacity is high, but the moisture held in the clayey subsoil is slowly available to plants. This soil takes in water slowly. Many areas contain shallow, distinct gullies. Runoff is rapid.

Much of the acreage is cultivated. Some areas are in abandoned cropland. In cultivated areas the main management needs are control of erosion, maintenance or improvement of fertility, and maintenance of good tilth. (Capability unit IIIe–6, Claypan range site, windbreak suitability group E)

Martin Series

The Martin series consists of deep, moderately well drained soils on uplands. These soils formed in material weathered from shale or sediments of similar nature. The slope gradient is 2 to 10 percent.

In a representative profile, the surface layer is very dark gray silty clay loam about 9 inches thick. The transitional layer to the subsoil is very dark gray heavy silty clay loam about 6 inches thick. The subsoil is very firm silty clay about 41 inches thick. It is grayish brown and is mottled with yellowish brown in the lower part. The substratum is grayish-brown silty clay. It is distinctly mottled with yellowish brown and gray.

Permeability is slow. Fertility is medium.

The native vegetation is primarily mixed tall and mid grasses. About 30 percent of the acreage is cultivated, and the rest is used for native range.

Representative profile of Martin silty clay loam, 2 to 6 percent slopes, under a cover of native range, 50 feet south and 2,680 feet west of the northeast corner of sec. 15, T. 18 S., R. 9 E.

A1—0 to 9 inches, very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) when moist; strong, fine and medium, granular structure; hard when dry, friable when moist; many roots; slightly acid; clear, smooth boundary.

AB—9 to 15 inches, very dark gray (10YR 3/1) heavy silty clay loam, black (10YR 2/1) when moist; strong, fine, subangular blocky structure; very hard when dry, firm when moist; many roots; slightly acid; gradual, smooth boundary.

B21t—15 to 29 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate, medium and coarse, angular blocky structure; extremely hard when dry, very firm when moist; distinct, thick, continuous clay films on many ped faces; few black spots; few fine roots; neutral; diffuse, smooth boundary.

B22t—29 to 43 inches, grayish-brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) with a few streaks of black (10YR 2/1) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6); moderate, coarse, angular blocky structure; extremely hard when dry, very firm when moist; distinct, thick, continuous clay films; few, small, black concretions; few, small, hard, calcium carbonate concretions; mildly alkaline; gradual, wavy boundary.

B3—43 to 56 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; common streaks of black (10YR 2/1) silty clay between peds; common, fine, distinct mottles of yellowish brown (10YR 5/6) when moist; weak, coarse, angular blocky structure; extremely hard when dry, very firm when moist; few, fine, black concretions; mildly alkaline; gradual, wavy boundary.

C—56 to 60 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; many, fine to coarse, distinct mottles of yellowish brown (10YR 5/6) and gray (10YR 5/1); massive; very hard when dry, very firm when moist; horizon contains some shale fragments; moderately alkaline.

The A horizon ranges from 7 to 14 inches in thickness, except in the eroded phase, and from very dark gray to grayish brown in color.

The AB horizon ranges from 3 to 6 inches in thickness and from very dark gray to grayish brown in color. The AB horizon ranges from light silty clay to silty clay loam in texture.

The B2t horizon ranges from 20 to 30 inches in thickness and from dark gray to grayish brown in color. The texture is clay or silty clay. In places the upper part of the B2t horizon is faintly mottled with brown and yellow.

The B3 horizon ranges from 6 to 15 inches in thickness and from gray to brown in color.

Reaction ranges from medium acid to slightly acid in the A and AB horizons and from slightly acid to neutral in the B21t horizon. It is neutral to mildly alkaline to moderately alkaline in the lower part of the B22t horizon and mildly alkaline in the B3 and C horizons. Reaction in all horizons except the A and AB horizons is more alkaline than the range described for the series, but this difference does not alter the behavior or usefulness of the soils.

In the eroded soils, the A horizon is thinner than the defined range of the series.

Martin soils have a thicker transitional layer from the A horizon to the B2t horizon and have a browner B2t horizon than the associated Ladysmith soils. They have a finer textured, grayer B2t horizon than that of the associated Tully soils. Martin soils have a coarser textured A horizon than the associated Zaar soils. They are deeper to bedrock than the associated Labette soils.

Martin silty clay loam, 2 to 6 percent slopes (Ma).—This soil has the profile described as representative for the series. It occurs on foot slopes that in most places are below limestone outcrops. The slopes are plane and convex, and the average gradient is 4 percent.

Included in mapping were some small areas of Zaar, Clime, and Tully soils. Also included were a few areas of eroded Martin soils. These areas are about 1 to 4 acres in size.

The available water capacity is high. This soil takes in water readily, and stored water is readily available to plants. Runoff is medium to rapid.

About 40 percent of the acreage is presently in cultivation, and the rest is in native range. In cultivated areas the main management need is the control of erosion. (Capability unit IIIe-4, Loamy Upland range site, windbreak suitability group C)

Martin silty clay loam, 2 to 6 percent slopes, eroded (Mc).—This soil is similar to that described as representative for the series, except that the surface layer has been thinned by erosion. The plow layer is more clayey than that of the uneroded soils. In about 75 percent of the acreage, the surface layer is dark-gray heavy silty clay loam. The A horizon is about 4 to 7 inches thick. This soil occurs on foot slopes that in most places are below limestone outcrops. The slopes are plane and convex, and the average gradient is 4 percent.

Included in mapping were minor areas of Zaar, Clime, and Tully soils.

The available water capacity is high. This soil takes in water slowly. Many areas contain shallow, distinct gullies. Runoff is rapid.

About half of the acreage is cultivated. The rest is abandoned cropland. In cultivated areas the main management needs are the control of erosion, the maintenance or improvement of fertility, and the maintenance of good tilth. (Capability unit IIIe-5, Clay Upland range site, windbreak suitability group C)

Martin-Gullied land complex (3 to 10 percent slopes) (Mg).—This complex consists of about 80 percent Martin soils and 20 percent Gullied land. The Martin soil has the profile described as representative for the series, except that the original surface layer has been thinned by erosion. The present surface layer is 4 to 7 inches thick and is heavy silty clay loam or silty clay. The areas of Gullied land are cut by deep gullies, and the profiles have been largely destroyed. Shale is exposed in the bottom of some of the gullies. In most places this complex is below limestone outcrops. The slopes are plane and convex, and the average gradient is 5 percent.

Included in mapping were minor areas of Zaar and Clime soils.

The soils take in water slowly, and runoff is rapid.

All of the acreage has been reseeded to grass or has reseeded naturally. The main management need is the control of erosion and maintenance or establishment of vegetative cover. (Capability unit VIe-1, Clay Upland range site, windbreak suitability group C)

Matfield Series

The Matfield series consists of deep, somewhat excessively drained to well-drained soils on uplands. These soils formed in material weathered from cherty limestone. In Chase County, Matfield soils are mapped only in a complex with Florence soils. The slope gradient is 1 to 5 percent.

In the representative profile, the surface layer is dark grayish-brown cherty silt loam about 22 inches thick (fig. 10). The subsurface layer is light-brown very cherty silt loam about 24 inches thick. The subsoil is extremely firm, dark-red very cherty clay. Below the subsoil is cherty limestone.

Permeability is very slow. Fertility is low.

The native vegetation is primarily mixed tall, mid, and short grasses. These soils are used for range.

Representative profile of Matfield cherty silt loam, under a cover of grass, in an area of Florence-Matfield cherty silt loams, 1,330 feet north and 2,150 feet east of the southwest corner of sec. 30, T. 21 S., R. 8 E.

A1—0 to 22 inches, dark grayish-brown (10YR 4/2) cherty silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and very fine, granular structure; slightly hard when dry, very friable when moist; horizon is 30 percent 1- to 3-inch size chert in the upper 12 inches and 60 to 70 percent chert in the lower part; many roots; some fine worm casts; medium acid; gradual, smooth boundary.

A21—22 to 42 inches, light-brown (7.5YR 6/3) very cherty silt loam, dark brown (7.5YR 4/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; horizon is 75 percent angular chert ½ inch to 4 inches across; few voids; few fine roots; worm casts; many open pores; medium acid; gradual, smooth boundary.

A22—42 to 46 inches, light-brown (7.5YR 6/4) very cherty silt loam, brown (7.5YR 4/3) when moist; massive; soft when dry, very friable when moist; horizon is 80 percent chert ½ inch to 5 inches in diameter; many voids; medium acid; abrupt, irregular boundary that has tonguing of A22 horizon into B2t horizon.

B2t—46 to 60 inches, dark-red (2.5YR 3/6) very cherty clay, dark reddish brown (2.5YR 3/4) when moist; moderate, fine, angular blocky structure; extremely hard when dry, extremely firm when moist; pronounced thick clay films on chert fragments; horizon is 80 percent chert 2 to 5 inches across; neutral.

The A1 horizon ranges from 15 to 30 inches in thickness and from grayish brown to dark grayish brown in color. The A2 horizon ranges from 10 to 40 inches in thickness and from brown to very pale brown in color.

The B2t horizon ranges from 20 to 60 inches in thickness and from reddish brown to dark red in color. The bedrock substratum is cherty limestone or shale. All horizons are

Figure 10.—**Profile of Matfield cherty silt loam, which contains many chert fragments. The surface layer is thick and lighter colored in the lower part.**

more than 35 percent angular chert, except in the upper part of the A1 horizon. In most places chert fragments, 1 to 5 inches in size, make up 50 to 80 percent of the horizon.

Reaction ranges from medium acid to slightly acid in the A1 horizon, from medium acid to neutral in the A2 horizon, and from slightly acid to neutral in the B2t horizon.

Matfield soils have a thicker A horizon, which is much lighter colored in the lower part, than the associated Florence soils. They have a thicker A horizon, which is lighter colored in the lower part than that of the similar Olpe soils. Matfield soils have angular chert in the A and B horizons, and the Olpe soils have rounded chert pebbles in the profile.

Olpe Series

The Olpe series consists of deep, well-drained, gravelly soils on uplands. These soils formed in material weathered from gravelly transported sediments. The slope range is 2 to 10 percent. In Chase County Olpe soils are mapped only in a complex with Smolan soils.

In a representative profile, the surface layer is dark grayish-brown gravelly silt loam about 9 inches thick. The upper part of the subsoil is firm, reddish-brown gravelly heavy clay loam about 9 inches thick. The lower part is very firm, reddish-brown gravelly silty clay about 42 inches thick.

Permeability is slow to very slow. Fertility is medium. The native vegetation is primarily mixed tall and mid grasses. Most areas are used for native range. Several gravel pits are in areas of Olpe soils.

Representative profile of Olpe gravelly silt loam, under a cover of native grass, in an area of Olpe-Smolan complex, 1,000 feet south of the northwest corner of sec. 22, T. 20 S., R. 8 E.

A1—0 to 9 inches, dark grayish-brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) when moist; strong, medium, granular structure; slightly hard when dry, friable when moist; weak, thin, platy structure in upper one inch; upper 3 inches is largely free of gravel; the lower 6 inches is 30 percent rounded chert pebbles ½ inch to 2½ inches across; many roots; medium acid; gradual, wavy boundary.

B1—9 to 18 inches, reddish-brown (5YR 4/3) gravelly heavy clay loam, dark reddish brown (5YR 3/3) when moist; strong, fine and very fine, subangular blocky structure; hard when dry, firm when moist; patchy clay films; horizon is 50 to 60 percent rounded chert pebbles ¼ inch to 3 inches across; many roots; slightly acid; gradual, wavy boundary.

B2t—18 to 60 inches, reddish-brown (2.5YR 4/4) gravelly silty clay, dark reddish brown (2.5YR 3/4) when moist; strong, fine and very fine, angular blocky structure; extremely hard when dry, very firm when moist; continuous, thick clay films; horizon is 80 to 85 percent rounded chert pebbles ¼ to 2½ inches across; few roots; neutral.

The A horizon ranges from 7 to 15 inches in thickness. The texture ranges from silt loam to gravelly silty clay loam.

The B1 horizon ranges from 4 to 10 inches in thickness and from dark reddish brown to reddish brown in color. The texture of the B1 horizon ranges from gravelly clay loam to gravelly heavy silty clay loam. The B2t horizon ranges from 15 to 45 inches in thickness and from reddish brown to yellowish red in color. The texture of the B2t horizon ranges from gravelly silty clay to gravelly clay.

All horizons are more than 35 percent rounded chert pebbles, except the upper part of the A1 horizon. In most places the range is from 50 to 80 percent content of chert pebbles.

Reaction ranges from slightly acid to strongly acid in the A1 horizon, from slightly acid to medium acid in the B1 horizon, and from medium acid to neutral in the B2t horizon.

Olpe soils have rounded chert pebbles throughout the profile, but in the similar Florence soils chert fragments are angular. Olpe soils have a thinner A horizon that is darker colored in the lower part than that of the similar Matfield soils. Olpe soils have rounded chert pebbles in the profile unlike the Matfield soils, in which the fragments of chert are angular. They have greater amounts of rounded chert pebbles in the profile than the associated Smolan soils.

Olpe-Smolan complex (2 to 10 percent slopes) (Om).—This complex is in narrow bands on uplands. About 60 percent of the acreage is Olpe soils, and 40 percent is Smolan soils. The Olpe and Smolan soils have the profile described as representative of their respective series, except that the lower part of the subsoil of the Smolan soil is gravelly silty clay.

The available water capacity is high in Smolan soils

and low in Olpe soils. Water is readily released for plant use. Runoff is medium to rapid.

These areas are used for range. A few areas are stripped for road gravel. Erosion is a limitation on cattle trails or where grass cover is thin. (Capability unit VIe-4, Loamy Upland range site. Olpe soils are in windbreak suitability group F, and Smolan soils are in windbreak suitability group C)

Osage Series

The Osage series consists of deep, poorly drained soils. These soils occur in backwater sediment areas of low stream terraces where the slope is less than 1 percent. They formed in clayey alluvium. These soils are subject to occasional flooding from streams, and they receive run-in water from adjacent uplands.

In a representative profile, the surface layer is very dark gray silty clay about 21 inches thick. The subsoil is extremely firm silty clay about 39 inches thick. It is very dark gray in the upper part and dark gray, faintly mottled with yellow and brown, in the lower part.

Permeability is very slow. The ground water rises in wet periods. Fertility is high.

The native vegetation is primarily tall grasses. Most areas are cultivated.

Representative profile of Osage silty clay, in a cultivated area, 25 feet south and 25 feet east of the middle of sec. 27, T. 19 S., R. 7 E.

Ap—0 to 8 inches, very dark gray (10YR 3/1) light silty clay, black (10YR 2/1) when moist; weak, fine, granular structure; very hard when dry, firm when moist; neutral in reaction; abrupt, smooth boundary.

A1—8 to 21 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate, fine and medium, angular blocky structure; extremely hard when dry, extremely firm when moist; a few peds have shiny surfaces; medium acid; diffuse, smooth boundary.

B2g—21 to 45 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; weak, coarse, angular blocky structure when dry, massive when moist; extremely hard when dry, extremely firm when moist; common slickensides about 45° from the horizontal and about 8 inches across; neutral; diffuse, smooth boundary.

B3g—45 to 60 inches, dark-gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; few, fine, faint mottles of yellowish brown (10YR 5/4); massive when moist; weak, coarse, blocky structure when dry; extremely hard when dry, extremely firm when moist; few, very small, black concretions; few slickensides; neutral.

The A1 horizon ranges from 13 to 26 inches in thickness and from dark gray to very dark grayish brown in color. The texture of the A horizon ranges from silty clay to very heavy silty clay loam in the upper 10 inches but is silty clay in the lower part of the A horizon. Structure of the A horizon ranges from granular to blocky in the upper part but is blocky in the lower part.

The B2g horizon is commonly free of mottles, and mottles are only faint in any part of the B horizon.

Reaction ranges from medium acid to neutral in the A horizon, from medium acid to neutral in the B2g horizon, and from slightly acid to mildly alkaline in the B3g horizon.

The Osage soils have a lower pH value than the associated Solomon soils. They have a finer textured A horizon than the associated Chase soils, and they are more poorly drained.

Osage silty clay (0 to 1 percent slopes) (Os).—This soil (fig. 11) is on low stream terraces. The slopes are plane to concave, and the average gradient is less than 1 percent.

Figure 11.—**An area of Osage silty clay. Depressional areas support prairie cordgrass, and higher areas support big bluestem and switchgrass.**

Included in mapping were small areas of Chase and Solomon soils.

The available water capacity is high, but the moisture held is slowly available to plants. This soil takes in water slowly. Runoff is slow, and the soil is under water at times of major flooding. Water is often ponded in wet periods.

Most of the acreage is cultivated. It is occasionally flooded, and wetness is a problem in wet years. In cultivated areas the main management needs are improvement of surface drainage, maintenance of fertility, and maintenance of good tilth. (Capability unit IIIw-1, Clay Lowland range site, windbreak suitability group B, woodland suitability group 2)

Reading Series

The Reading series consists of deep, well-drained soils on low stream terraces. These soils formed in silty alluvium. They are occasionally flooded, but floodwaters seldom damage the crops or the soils. The slope range is 0 to 12 percent.

In a representative profile, the surface layer is dark grayish-brown silt loam about 17 inches thick. The upper part of the subsoil is firm, dark grayish-brown silty clay loam about 7 inches thick. The lower part is firm silty clay loam about 36 inches thick; it is dark grayish brown in the upper part and brown in the lower part.

Permeability is moderately slow. Fertility is high.

The native vegetation is primarily tall grasses and a few hardwood trees. Most areas are cultivated.

Representative profile of Reading silt loam, 0 to 1 percent slopes, in a cultivated field, 1,540 feet east and 440 feet south of the northwest corner of SW1/4 sec. 17, T. 18 S., R. 7 E.

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak, fine and very fine, granular structure; slightly hard when dry, friable when moist; many roots; few wormholes and worm casts; slightly acid; abrupt, smooth boundary.

A1—8 to 17 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; many roots; many wormholes and worm casts; slightly acid; gradual, smooth boundary.

B1—17 to 24 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; strong, fine and very fine, subangular blocky structure; hard when dry, firm when moist; dark coatings are thin and patchy; many roots; few wormholes and worm casts; slightly acid; gradual, smooth boundary.

B21t—24 to 40 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; when moist soil is crushed, the color is dark brown (10YR 3/3); moderate, fine and medium, subangular blocky structure; hard when dry, firm when moist; distinct, thick, discontinuous clay films that are darker than ped interiors; few fine sand grains; few wormholes and worm casts; slightly acid; diffuse, smooth boundary.

B22t—40 to 48 inches, brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6) when dry; moderate, medium, angular and subangular blocky structure; hard when dry, firm when moist; few thin patchy clay films; few wormholes and worm casts; neutral; diffuse, smooth boundary.

B3—48 to 60 inches, brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure; hard when dry, firm when moist; few fine wormholes; neutral.

The A horizon ranges from 10 to 20 inches in thickness, except in the eroded phase, and from dark gray to grayish brown in color. The texture of the A horizon ranges from silt loam to light silty clay loam.

The B1 horizon ranges from 4 to 10 inches in thickness and from dark gray to grayish brown in color. The B2t horizon ranges from 14 to 25 inches in thickness and from dark grayish brown to brown in color. Structure is largely subangular blocky, but in places it is blocky at a depth below 36 inches. The B3 horizon ranges from 6 to 16 inches in thickness and from dark grayish brown to yellowish brown in color.

Some profiles are free of mottles, but others have faint mottles at a depth below 40 inches.

Reaction ranges from medium acid to slightly acid in the A horizon and upper part of the B horizon, and from slightly acid to neutral in the lower part of the B horizon.

In the eroded soils, the A1 horizon is thinner than is defined as the range for the series.

Reading soils have a coarser textured profile than the associated Chase soils. They are more clayey and have a B2t horizon, unlike the associated Kahola soils. Reading soils have a less clayey B2t horizon than the associated Tully soils.

Reading silt loam, 0 to 1 percent slopes (Ra).—This soil has the profile described as representative for the series. It occurs on broad, nearly level, low terraces. The slopes are plane and convex, and the average gradient is less than 1 percent.

Included in mapping were small areas of Chase and Kahola soils.

The available water capacity is high. This soil takes in water readily, and stored water is readily available to plants. Runoff is slow.

Most areas of this soil are presently being tilled. The chief management needs in cultivated areas are to maintain fertility and good tilth. (Capability unit I-1, Loamy Lowland range site, windbreak suitability group A, woodland suitability group 3)

Reading silt loam, 1 to 3 percent slopes (Rd).—This soil occurs on broad, gently sloping stream terraces. The slopes are plane and convex, and the average gradient is 2 percent.

Included in mapping were a few small areas of Tully soils.

The available water capacity is high. This soil takes in water readily, and stored water is readily available to plants. Runoff is medium to slow.

Most of this soil is in cultivation. In cultivated areas the main management needs are control of erosion and maintenance of fertility and good tilth. (Capability unit IIe-2, Loamy Upland range site, windbreak suitability group A, woodland suitability group 3)

Reading soils, 6 to 12 percent slopes, eroded (Re).—This soil has the profile described as representative for the series, except that the surface layer has been thinned by erosion. The surface layer is about 5 to 10 inches thick and is heavy silt loam or silty clay loam. The slopes are plane and convex and are short. The average gradient is 8 percent.

Included in mapping were small areas of Ivan and Kahola soils.

The available water capacity is high. Stored water is readily available for plant use. Runoff is rapid.

Most areas are presently in cultivation. In cultivated areas the main management needs are the control of erosion and the maintenance of fertility and good tilth. (Capability unit IVe-3, Loamy Upland range site, windbreak suitability group A, woodland suitability group 3)

Smolan Series

The Smolan series consists of deep, moderately well drained to well drained soils on uplands. These soils formed in material weathered from reddish-colored clayey sediment. The slope range is 2 to 6 percent.

In a representative profile, the surface layer is dark-brown silty clay loam about 15 inches thick. The upper part of the subsoil is firm, brown silty clay loam about 4 inches thick. The lower part is very firm silty clay about 41 inches thick. It is reddish brown and is mottled with very dark gray, yellowish brown, and dark grayish brown in the lower part.

Permeability is slow, and fertility is medium.

The native vegetation is mixed tall and mid grasses. Most areas are cultivated.

Representative profile of Smolan silty clay loam, 2 to 6 percent slopes, in a cultivated area, 500 feet west and 100 feet south of the northeast corner of sec. 15, T. 22 S., R. 6 E.

Ap—0 to 8 inches, dark-brown (7.5YR 4/2) light silty clay loam, very dark brown (7.5YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many roots; neutral; abrupt, smooth boundary.

A1—8 to 15 inches, dark-brown (7.5YR 4/2) silty clay loam, very dark brown (7.5YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; many roots; medium acid; gradual, smooth boundary.

B1—15 to 19 inches, brown (7.5YR 5/3) silty clay loam, dark brown (7.5YR 3/3) when moist; moderate, fine and very fine, subangular blocky structure; hard when dry, firm when moist; few, thin, discontinuous clay films; few very fine sand grains; few roots; medium acid; gradual, smooth boundary.

B21t—19 to 27 inches, reddish-brown (5YR 5/3) light silty clay, dark reddish brown (5YR 3/3) when moist;

moderate, fine, angular blocky structure with a subangular blocky component; very hard when dry, very firm when moist; distinct, thick, continuous clay films that bridge many ped faces; medium acid; diffuse, smooth boundary.

B22t—27 to 42 inches, reddish-brown (5YR 5/4) silty clay, dark reddish brown (5YR 3/4) when moist; common, fine, distinct mottles of dark grayish brown (10YR 4/2); weak, medium, angular blocky structure; very hard when dry, very firm when moist; few, indistinct, discontinuous clay films; few, fine, soft, black concretions; very few fine chert chips; medium acid; diffuse, smooth boundary.

B3—42 to 60 inches, reddish-brown (5YR 5/4) silty clay, dark reddish brown (5YR 3/4) when moist; common, fine, faint mottles of very dark gray (10YR 3/1) and yellowish brown (10YR 5/6); weak, fine, angular blocky structure; very hard when dry, very firm when moist; few, fine, soft, black concretions; mildly alkaline.

The A horizon ranges from 9 to 15 inches in thickness and from dark grayish brown to dark brown in color. The texture of the A horizon is mostly silty clay loam, but it ranges from heavy silt loam to silty clay loam.

The B1 horizon ranges from 4 to 7 inches in thickness and from brown to reddish brown in color. The B2t horizon ranges from 10 to 25 inches in thickness. In places the lower part of the B2t horizon is mottled with brown and yellow. The B3 horizon is light yellowish brown to reddish brown. In some places calcium carbonate concretions occur in the lower part of the B3 horizon.

In areas where Smolan soils occur with Olpe soils, the texture of the B3 horizon is gravelly silty clay that is more than 50 percent rounded chert gravel.

The B2t horizon is thicker, and the lower part of the B2t horizon is more mottled than is characteristic for the series, but these differences do not alter the usefulness or behavior of the soils.

Reaction ranges from neutral to medium acid in the A horizon and B2t horizon. It is neutral to moderately alkaline in the B3 horizon.

Smolan soils are deeper to bedrock than the associated Labette soils. They have a thicker transitional layer from the A1 horizon to the B2t horizon than the associated Irwin soils and a less clayey B2t horizon. Smolan soils have a browner, coarser textured B2t horizon than the associated Tully soils, which formed in slope wash. They have fewer rounded chert pebbles in the profile than the associated Olpe soils.

Smolan silty clay loam, 2 to 6 percent slopes (Sm).—This soil is on gently sloping to sloping, high terraces. The slopes are convex, and the average gradient is 3 percent.

Included in mapping were small areas of Tully and Irwin soils. A few eroded areas were also included. These areas are about 1 to 4 acres in size.

The available water capacity is high, and water is readily available to plants. Runoff is medium to rapid.

About 50 percent of the acreage is cultivated, and the rest is in native range. In cultivated areas the main management need is to control erosion. (Capability unit IIIe-4, Loamy Upland range site, windbreak suitability group C)

Sogn Series

The Sogn series consists of shallow and very shallow, somewhat excessively drained soils on uplands. These soils formed in material weathered from limestone. The slope range is mainly 2 to 12 percent. In Chase County Sogn soils are mapped only in complexes with other soils.

In a representative profile (fig. 12), the surface layer is dark grayish-brown silty clay loam about 6 inches thick. Below the surface layer is platy, massive limestone with few cracks or crevices.

Figure 12.—**Profile of a Sogn soil. This soil is shallow over limestone.**

Permeability is moderate. Fertility is medium.

The native vegetation is mixed mid and short grasses. Most areas are used for range.

Representative profile of a Sogn soil, under a cover of native range, in an area of Clime-Sogn complex, 200 feet west and 100 feet north of the southeast corner of NE¼ sec. 23, T. 20 S., R. 9 E.

A1—0 to 6 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many roots; mildly alkaline; few limestone chips; abrupt, smooth boundary.

R—6 inches, platy, massive limestone with few crevices.

The A1 horizon ranges from 4 to 20 inches in thickness and from dark gray to grayish brown in color. The underlying limestone rock is slablike or massive. In most areas the thickness of the A1 horizon is less than 15 inches.

The reaction of the A horizon is slightly acid to moderately alkaline.

Sogn soils are not so deep as the associated Labette soils, which have a silty clay B2t horizon. Sogn soils are shallower to bedrock and are coarser textured than the associated calcareous Clime soils.

Solomon Series

The Solomon series consists of deep, poorly drained, calcareous soils on low stream terraces. These soils occur in backwater sediment areas. They formed in calcareous, clayey alluvium. They are subject to occasional flooding from streams and to run-in water from adjacent uplands. The slopes are concave, and the gradient is less than 0.5 percent.

In a representative profile, the surface layer is very dark gray, calcareous silty clay about 18 inches thick. The subsoil is very firm, calcareous, very dark gray silty clay about 42 inches thick.

Permeability is very slow. The water table rises in wet periods. Fertility is high.

The native vegetation is primarily tall grasses. Most areas are cultivated.

Representative profile of Solomon silty clay, in a cultivated area, 50 feet west and 1,000 feet south of the northeast corner of sec. 36, T. 20 S., R. 5 E.

A1g—0 to 18 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; weak, fine, granular structure in upper 8 inches; structure in lower part is moderate, coarse, granular and moderate, medium, angular blocky in about equal parts; extremely hard when dry, very firm when moist; many shiny surfaces on peds; mildly alkaline; calcareous; gradual, smooth boundary.

B2g—18 to 30 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; weak, fine, angular blocky structure when wet; weak, coarse and very coarse, angular blocky structure when dry; extremely hard when dry, very firm when moist; many shiny surfaces on peds; moderately alkaline; calcareous; diffuse, smooth boundary.

B3g—30 to 60 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6); massive; extremely hard when dry, very firm when moist; few small calcium carbonate concretions; moderately alkaline; calcareous.

The A horizon ranges from 11 to 26 inches in thickness and from very dark gray to gray in color. The texture ranges from silty clay to heavy silty clay loam in the upper 10 inches but is silty clay in the lower part of the A horizon.

The B2g horizon ranges from 12 to 24 inches in thickness and from very dark gray to gray in color. The B3g horizon is very dark gray to gray.

The depth to free carbonates is 0 to 10 inches. Reaction ranges from mildly alkaline to moderately alkaline in the A horizon and from moderately alkaline to strongly alkaline in the B2g and C horizons.

Solomon soils have a more alkaline profile than the associated Osage soils.

Solomon silty clay (0 to 1 percent slopes) (So).—This soil is on low stream terraces. The slopes are plane or concave, and the average gradient is less than 0.5 percent.

The available water capacity is high, but the moisture held in this clayey soil is slowly available to plants. This soil takes in water slowly. Runoff is very slow.

Most areas are in cultivation.

This soil is occasionally flooded, and wetness is a limitation in wet years. In cultivated areas the main management needs are improvement of surface drainage and maintenance of fertility and good tilth. (Capability unit IIIw-1, Clay Lowland range site, woodland suitability group 2, windbreak suitability group B)

Stony Steep Land

Stony steep land (30 to 50 percent slopes) (St) consists of very shallow soils intermixed with deeper soils and limestone outcrops in steep and very steep areas on uplands.

The soils are excessively drained, and runoff is rapid. The available water capacity is low in the shallow soils, and they are droughty. The available water capacity is medium in the deeper soils.

Most areas of this land type are used for range. A few areas are used for woodland. The native vegetation is mostly mixed mid and tall prairie grasses. (Capability unit VIIe-1, Breaks range site, windbreak suitability group F)

Tully Series

The Tully series consist of deep, well-drained soils on uplands. These soils formed in slope wash or in sediments of similar nature. The slope range is 3 to 15 percent.

In a representative profile, the surface layer is very dark grayish-brown silty clay loam about 14 inches thick. The upper part of the subsoil is firm, dark grayish-brown heavy silty clay loam about 5 inches thick. The lower part is very firm silty clay about 41 inches thick. It is dark grayish brown in the upper two-thirds and brown in the lower third; it is mottled with yellowish brown.

Permeability is slow. Fertility is medium.

The native vegetation is mixed tall and mid grasses. The more gently sloping areas of Tully soils are used for cultivated crops and native range. The steeper areas are used for native range.

Representative profile of Tully silty clay loam, 3 to 7 percent slopes, under a cover of native range, 200 feet east and 740 feet north of the southwest corner of SE¼ sec. 26; T. 22 S., R. 6 E.

A1—0 to 14 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate, medium and fine, granular structure; slightly hard when dry, friable when moist; many roots; medium acid; clear, smooth boundary.

B1—14 to 19 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam, very dark brown (10YR 2/2) when moist; strong, fine, subangular blocky structure; hard when dry, firm when moist; few shiny surfaces on peds; few fine chert chips; many roots; medium acid; clear, smooth boundary.

B21t—19 to 32 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6); moderate, medium and coarse, angular blocky structure; very hard when dry, very firm when moist; distinct, thick and continuous clay films that clog some pores; few fine chert chips; common fine roots; slightly acid; gradual, smooth boundary.

B22t—32 to 49 inches, dark grayish-brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; common, fine, distinct mottles of yellowish brown (10YR 5/6) and some mottles of strong brown; weak, medium and coarse, angular blocky structure; very hard when dry, very firm when moist; few fine chert chips; few, fine, pea-size calcium carbonate concretions; few roots; neutral; gradual, smooth boundary.

B3—49 to 60 inches, brown (10YR 5/3) silty clay, dark brown (10YR 3/3) when moist; common, fine faint mottles of yellowish brown (10YR 5/6); weak angular blocky structure; very hard when dry, very firm when moist; some black streaks and black concretions; few fine chert chips; few, hard, small calcium carbonate concretions; neutral.

The A horizon ranges from 7 to 14 inches in thickness except in the eroded phase, and from very dark gray to grayish brown in color. The texture of the A horizon ranges from heavy silt loam to silty clay loam.

The B1 horizon ranges from 4 to 8 inches in thickness. The B2t horizon ranges from 17 to 36 inches in thickness and from dark grayish brown to brown in color. The B3 horizon ranges from 6 to 12 inches in thickness and from light brownish gray to yellowish brown in color.

The thickness of horizons over layers that are 40 percent or more clay exceeds 14 inches.

In the eroded soils the A1 horizon is thinner than is defined as the range for the series.

Reaction ranges from neutral to medium acid in the A and B1 horizons, from slightly acid to moderately alkaline

in the B2t horizon, and from neutral to moderately alkaline in the B3 horizon.

Tully soils have a less brown and finer textured B2t horizon than the associated Smolan soils. They have a thicker transitional horizon from the A1 horizon to the B2t horizon than the associated Irwin soils, and they have a less clayey B2t horizon than the associated Irwin soils. Tully soils have a finer textured B2t horizon than do the associated Reading soils. They are deeper to bedrock than the associated Labette soils, which are underlain by limestone or shale. They have a less clayey, browner colored B2t horizon than do the associated Martin soils.

Tully silty clay loam, 3 to 7 percent slopes (Tc).—This soil has the profile described as representative for the series. It occurs on slopes below rocky areas, generally near streams. The slopes are plane and convex, and the average gradient is 4.5 percent.

Included in mapping were small areas of Irwin, Dwight, Martin, and Smolan soils. Also included were a few areas of eroded Tully soils. These areas are about 1 to 4 acres in size.

The available water capacity is high, and stored water is readily available to plants. This soil takes in water well. Runoff is medium.

About 30 percent of the acreage is cultivated, and the remainder is used for native range. In cultivated areas the main management need is the control of erosion. (Capability unit IIIe-4, Loamy Upland range site, windbreak suitability group C)

Tully silty clay loam, 3 to 7 percent slopes, eroded (Ts).—The surface layer of this soil has been thinned by erosion, but the profile is otherwise similar to that described as representative for the series. The surface layer is about 3 to 7 inches thick. In about 75 percent of the acreage, the surface layer is grayish-brown heavy silty clay loam. This soil occurs on slopes below rocky areas, generally near streams. The slopes are plane and convex, and the average gradient is 4.5 percent.

Included in mapping were minor areas of Irwin, Dwight, Smolan, and Martin soils.

The available water capacity is high, and stored water is readily available to plants. Many areas contain distinct gullies. Runoff is rapid.

Most areas of this soil are cultivated. Some areas that were once cultivated have been allowed to reseed naturally and are used for grazing. The main management needs in cultivated areas are controlling erosion, maintaining or improving fertility, and maintaining good tilth. (Capability unit IIIe-5, Clay Upland range site, windbreak suitability group C)

Tully cherty silty clay loam, 5 to 15 percent slopes (Tu).—This soil is in broad areas of uplands. About 70 percent of the acreage is Tully soils, and 30 percent is Martin and Clime soils. There are rock outcrops in some places. This soil has a profile similar to that described as representative of the series, except that angular chert makes up 10 to 20 percent of the soil mass throughout the profile.

The available water capacity is high. These soils release water rapidly for plant use. Runoff is medium to rapid.

These soils are used for range. Erosion is a hazard on cattle trails, where grass cover is thin, or around drainageways. (Capability unit VIe-4, Loamy Upland range site, windbreak suitability group F)

Zaar Series

The Zaar series consists of deep, somewhat poorly drained to moderately well drained soils on uplands. These soils are on drainage divides and side slopes. They formed in material weathered from clayey shale or sediments of similar nature. The slope range is 1 to 7 percent.

In a representative profile, the surface layer is very dark gray silty clay about 15 inches thick. The subsoil is extremely firm silty clay about 39 inches thick; it is dark grayish brown in the upper part and grayish brown in the lower part. The substratum is grayish-brown silty clay and white clay shale.

Permeability is very slow. Fertility is medium.

The native vegetation is primarily mid grasses. Most areas are used for range, but some are used for cultivated crops.

Representative profile of Zaar silty clay, 3 to 7 percent slopes, under a cover of native range, 1,600 feet west and 2,000 feet south of the northeast corner of sec. 11, T. 21 S., R. 9 E.

A11—0 to 8 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; strong, medium, granular structure; very hard when dry, firm when moist; many roots; slightly acid; gradual, wavy boundary.

A12—8 to 15 inches, very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate, medium, subangular and angular blocky structure; extremely hard when dry, very firm when moist; common fine roots concentrated on ped faces; few small chert chips; slightly acid; gradual, wavy boundary.

B2—15 to 33 inches, dark grayish-brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; few, fine, faint mottles of yellowish brown (10YR 5/6); weak, coarse, angular blocky structure when dry; extremely hard when dry, extremely firm when moist; some slickensides about 10 inches across that intersect at an angle of 45°; few small chert chips; very few flattened roots; few black coats on peds and cleavage planes; few, small, hard, black concretions; moderately alkaline but noncalcareous; diffuse, wavy boundary.

B3—33 to 54 inches, grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (5Y 3/2) when moist; many, fine, faint mottles of yellowish brown (10YR 5/6) and black (10YR 2/1); massive to weak, coarse, blocky structure; extremely hard when dry, very firm when moist; some slickensides that are wider than in B2 horizon; common, fine, hard, black concretions; few, small (pea size to one-half inch across), calcium carbonate concretions; moderately alkaline but noncalcareous; clear, wavy boundary.

C—54 to 60 inches, mixture of white (10YR 8/2) clay shale, light gray (10YR 7/2) when moist and grayish-brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; many coarse mottles of yellowish brown (10YR 5/6) on the silty clay part; the weathered shale has weak platy structure; the silty clay is massive and extremely hard when dry, very firm when moist; moderately alkaline and calcareous in shale part; moderately alkaline but noncalcareous in silty clay part.

The A horizon ranges from 12 to 20 inches in thickness and from grayish brown to very dark gray in color. The texture of the A horizon ranges from heavy silty clay loam to silty clay.

The B2 horizon ranges from 16 to 38 inches in thickness and from very dark gray to brown in color. The B3 horizon ranges from 10 to 30 inches in thickness and from very dark gray to brown in color.

The C horizon ranges in percentage of shale from only a few fragments to mostly weathered shale. Depth to little altered shale is more than 45 inches.

Reaction ranges from medium acid to slightly acid in the A horizon and neutral to moderately alkaline in the B and C horizons.

Zaar soils have a finer textured A horizon than the associated Martin soils. They are deeper over bedrock and are less alkaline in the A horizon than the associated Clime soils.

Zaar silty clay, 3 to 7 percent slopes (Za).—This soil has the profile described as representative for the series. It generally occurs in association with limestone outcrops. The slopes are plane and convex, and the average gradient is 5 percent.

Included in mapping were small areas of Dwight, Clime, and Martin soils.

The available water capacity is high. This soil takes in water slowly and gives up water slowly to plants. Runoff is medium.

Most areas are in native range. In cultivated areas the main management needs are controlling erosion, maintaining or improving fertility, and maintaining good tilth. (Capability unit IIIe-5, Clay Upland range site, windbreak suitability group E)

Zaar-Dwight complex, 1 to 3 percent slopes (Zd).—This complex is on uplands. About 55 percent of the acreage is Zaar soils, and 45 percent is Dwight soils.

Included in mapping were small areas of Labette, Clime, Ladysmith, and Martin soils.

The available water capacity is high in Zaar soils but moderate in Dwight soils. Both Zaar and Dwight soils take in water slowly and release it slowly for plant use. Runoff is medium.

About 90 percent of the acreage is used for range. About 10 percent is used for crops. In cultivated areas the main management need is control of erosion. (Capability unit IIIe-2; windbreak suitability group E; Dwight part in Claypan range site, Zaar part in Clay Upland range site)

Use and Management of the Soils

The soils of this survey area are used mainly for summer range and for growing feed for livestock. The principal feed crops are corn, sorghum, alfalfa, and bromegrass.

This section discusses the use of the soils for these main purposes and also for woodland and windbreaks, for wildlife habitat, and for engineering uses. It explains the system of capability grouping and gives predicted yields of the principal crops.

Management of the Soils for Crops [3]

Using and managing cropland soils efficiently will bring favorable yields over a period of years without lessening the productivity of the soils. If the soils are to be managed properly, each soil should be used for the crop or purpose to which it is best suited. Improved management practices are needed to reduce the loss of organic matter in cultivated soils. Organic matter is important to the maintenance of good soil structure, to infiltration and percolation, and to the control of erosion.

To conserve cropland soils, it is necessary to use a system of management that includes a suitable cropping system, minimum tillage, and the optimum use of fertilizer so that crops produce more residue. Manure should be added, and all crop residue should be returned to the soil to maintain or improve soil structure and tilth. Terracing, contour farming, and keeping grass in waterways helps to reduce runoff from sloping uplands and control erosion. Drainage is needed on some soils on bottom lands. Good management consists of a combination of practices.

Corn and sorghum for grain and silage, small grains, alfalfa, sweetclover, and bromegrass are the crops commonly grown in the county. These crops respond well to the use of commercial fertilizer, lime, and manure on most cultivated soils. The kind and amount of fertilizer to use for each crop should be determined by soil tests and field trials.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or engineering.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have several limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove,

[3] Prepared with the assistance of EARL J. BONDY, conservation agronomist, Soil Conservation Service, Salina.

that limit their use largely to pasture, range, woodland, or wildlife habitat. (None in this county)

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes. (None in this county)

Capability Subclasses are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States but not in Chase County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

Capability Units are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIe-4 or VIe-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Chase County are described, and suggestions for the use and management of the soils are given.

The names of the soil series represented are mentioned in the description of each capability unit, but the listing of the series name does not necessarily indicate that all the soils of a series are in the same capability unit. The capability classification of any given soil can be learned by referring to the "Guide to Mapping Units."

CAPABILITY UNIT I-1

This unit consists of deep soils of the Kahola and Reading series. These soils are on low terraces and high bottoms. They have a surface layer of silt loam and a subsoil of friable silt loam to firm silty clay loam. They are seldom subject to damaging floods. The slope range is 0 to 2 percent.

These soils are high in fertility. They take in water well if the surface layer is kept in good condition. They store large amounts of water, which is readily available for plant use. Management is needed mainly to maintain fertility and good tilth.

These soils are suited to all crops commonly grown in the county, including vegetable crops. They are suited to irrigated crops where irrigation water is available. Corn and sorghum may be grown on these soils year after year if all crop residue is returned to the soil or if manure is added when silage is grown. Alfalfa, wheat, row crops, and bromegrass pasture are the main crops (fig. 13).

These soils are also suited to tame and native perennial grasses, to trees for windbreaks, and to the development of wildlife habitat.

CAPABILITY UNIT IIe-1

This unit consists only of Labette silty clay loam, 1 to 3 percent slopes. This soil is on uplands. It is moderately deep. It has a surface layer of silty clay loam and a subsoil of firm silty clay. It is underlain by limestone or shale at depths of 20 to 40 inches.

This soil has medium fertility. It takes in water well if the surface layer is in good condition. The available water capacity is moderate to low. Water capacity is limited by the underlying shale or limestone, but the stored water is readily available for plant use. Management is needed mainly to control erosion, but also to maintain fertility and good tilth.

This soil is suited to all crops commonly grown in the county. In some years yields of corn and alfalfa are suppressed because of moderate to low available water capacity. This soil is also suited to tame and native perennial grasses, to trees for windbreaks, and to development of wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion.

CAPABILITY UNIT IIe-2

This unit consists only of Reading silt loam, 1 to 3 percent slopes. This soil is deep and on low terraces. It

Figure 13.—Alfalfa on Reading silt loam, 0 to 1 percent slopes.

has a surface layer of silt loam and a subsoil of firm silty clay loam.

This soil is high in fertility. It takes in water well if the surface layer is in good condition. It stores large amounts of water, which is readily available for plant use. Management is needed mainly to control erosion, but also to maintain fertility and good tilth.

This soil is suited to all crops commonly grown in the county. Grain sorghum is a more dependable producer than corn on these gently sloping soils. This soil is suited to irrigated crops where irrigation water is available. Wheat, row crops, and alfalfa are the main crops. This soil is suited to native and tame perennial grasses, to trees for windbreaks, and to the development of wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion.

CAPABILITY UNIT IIw-1

This unit consists only of Ivan silt loam. This soil is on flood plains. It is deep and calcareous. It has a surface layer and subsoil of silt loam. It is subject to frequent flooding.

This soil is high in fertility. It takes in water well if the surface layer is in good condition. The available water capacity is high. Stored water is readily available for plant use. This soil is subject to scouring and siltation by floodwaters. Management is needed mainly to control erosion, limit flood damage to crops, and to maintain the organic-matter content and fertility.

This soil is suited to all common crops grown in the county. In many years small grains and alfalfa crops are lost because of flooding. Corn and sorghum can be grown year after year if all crop residue is returned to the soil. Corn, sorghum, and bromegrass are the main crops. This soil is well suited to tame pasture. If used for this purpose, woody sprouts need to be controlled. This soil is suited to perennial pasture, to woodland, and to the development of wildlife habitat.

The risk of scouring by floodwaters is reduced if plowing is done only a short time before planting.

CAPABILITY UNIT IIw-2

This unit consists only of Chase silty clay loam. This soil is deep and is on the low stream terraces. It has a surface layer of silty clay loam and a subsoil of very firm silty clay. It is subject to occasional flooding.

This soil is high in fertility and high in available water capacity. It takes in and releases water readily if the surface layer is kept in good condition. Some crop loss is experienced in wet periods. Management is needed mainly to maintain fertility and good tilth.

This soil is suited to all crops commonly grown in the county. Corn and sorghum may be grown year after year if all crop residue is returned to the soil. It is suited to irrigated crops where high-quality irrigation water is available. Wheat, row crops, and alfalfa are the main crops. This soil is also suited to tame and native perennial grasses, to trees for windbreaks, and to the development of wildlife habitat.

A system of bedding improves drainage in the few areas where surface drainage is needed.

CAPABILITY UNIT IIs-1

This unit consists only of Ladysmith silty clay loam, 0 to 1 percent slopes. This deep soil is on uplands. It has a surface layer of light silty clay loam and a subsoil of very firm silty clay.

This soil is medium in fertility. It takes water in slowly and releases it slowly to crops. It is droughty in dry years and can be slightly wet in wet years. The main management need is maintenance of fertility.

This soil is a dependable producer of small grains and alfalfa. Row crops are less dependable because of summer drought and slow release of water. Wheat, sorghum, and alfalfa are the main crops. This soil is also suited to tame and native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Bedding and open drains, where needed, can be used to remove excess water. Contour farming and keeping grass in waterways help to control runoff. Deep-rooted legumes improve the water intake.

CAPABILITY UNIT IIIe-1

This unit consists of deep soils of the Ladysmith and Irwin series. These soils are on uplands. They have a surface layer of silty clay loam and a subsoil of very firm silty clay. The slope range is 1 to 3 percent.

These soils are medium in fertility. They take in water slowly and release it slowly to plants. They are droughty in dry years. They are susceptible to erosion if not protected. The main management need is the control of erosion, but management is also needed to maintain fertility and good tilth.

These soils are suited to wheat, sorghum, and alfalfa. Sorghum is a less dependable producer than wheat because of summer drought and slow release of water by these soils. These soils are also suited to tame and native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grasses in waterways help to control erosion on these soils (fig. 14). Deep-rooted legumes, if used in the cropping system, improve the water intake.

CAPABILITY UNIT IIIe-2

This unit consists of the Labette-Dwight complex, 1 to 3 percent slopes, and the Zaar-Dwight complex, 1 to 3 percent slopes. These soils are on uplands. The Labette soil is moderately deep. It has a surface layer of silty clay loam and a subsoil of firm silty clay. The Dwight soil is deep. It has a surface layer of thin silt loam and a subsoil of extremely firm silty clay. The Zaar soil is deep. It has a surface layer of silty clay and a subsoil of extremely firm silty clay.

The Labette soil is medium in fertility. It takes in water well if the surface layer is in good condition. The available water capacity is moderate to low, but stored water is readily available for plant use. The Dwight soil is low in fertility. It takes in water slowly. This soil has moderate available water capacity but releases it slowly for plant use. The Zaar soil is medium in fertility. It takes in water slowly. The available water capacity is high, but stored water is slowly available for plant use.

All soils in this unit are susceptible to sheet and gully erosion. Management is needed to control erosion, but also to maintain fertility and good tilth.

Figure 14.—**Contoured and terraced row crops on Ladysmith silty clay loam, 1 to 3 percent slopes.**

These soils are not suited to alfalfa, corn, or soybeans. They are suited to sorghum, wheat, and pasture crops. They are suited to native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion on these soils. Erosion is excessive on these soils where residue is plowed under. If residue is incorporated into the surface layer, it increases moisture intake and helps to control erosion.

CAPABILITY UNIT IIIe-3

This unit consists only of Labette silty clay loam, 3 to 5 percent slopes. This soil is on uplands. It is moderately deep. It has a surface layer of silty clay loam and a subsoil of firm silty clay. It is underlain by limestone or shale at depths of 20 to 40 inches.

This soil is medium in fertility. It takes in water well if the surface layer is kept in good condition. The available water capacity is moderate to low. Water capacity is limited by the underlying shale or limestone, but the stored water is readily available for plant use. It is susceptible to sheet and gully erosion if not protected. Management is needed mainly to control erosion, but also to maintain fertility and good tilth.

This soil is suited to all crops commonly grown in the county. Wheat, sorghum, and alfalfa are the main crops. This soil is also suited to tame and native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion.

CAPABILITY UNIT IIIe-4

This unit consists of deep soils of the Martin, Smolan, and Tully series. These soils are on uplands. They have a surface layer of silty clay loam and a subsoil of very firm silty clay. The slope gradient is 2 to 7 percent.

These soils are medium in fertility. They take in water well if the surface layer is kept in good condition. They store large amounts of water, which is readily available for plant use. They are susceptible to sheet and gully erosion if not protected. Management is needed mainly to control erosion, but also to maintain fertility and good tilth.

These soils are suited to all the common crops grown in the county. Corn and soybeans are not so dependable as small grain and sorghum. Wheat, sorghum, and alfalfa are the main crops. These soils are also suited to tame and native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming (fig. 15), and keeping grass in waterways help to control erosion.

Figure 15.—**Plowing on the contour supported by terraces. The soil is Martin silty clay loam, 2 to 6 percent slopes.**

CAPABILITY UNIT IIIe-5

This unit consists of soils of the Irwin, Martin, Tully, and Zaar series. These are deep soils on uplands. They have a surface layer of silty clay loam or silty clay and a subsoil of very firm to extremely firm silty clay. The slope range is 2 to 7 percent. The Martin and Tully soils are eroded.

These soils are medium in fertility. They take in water slowly. The available water capacity is high, but the stored water is slowly available for plant use. These soils are subject to sheet and gully erosion if not protected. The main management needs are the control of erosion, the maintenance or improvement of fertility, and the maintenance of good tilth.

These soils are suited to wheat, sorghum, and alfalfa. They are also suited to tame and native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion. Erosion is excessive where residue is plowed under. Where residue is incorporated into the surface layer, it helps to increase moisture intake and to control erosion.

CAPABILITY UNIT IIIe-6

This unit consists of deep soils of the Ladysmith and Irwin series. These soils are on uplands. They have an eroded surface layer of heavy silty clay loam and a subsoil of very firm silty clay. The surface layer has been thinned by erosion, and there is some mixing of the clay subsoil into the plow layer.

These soils are medium in fertility. They take in water slowly and lose much water through runoff. They are difficult to till and release water slowly for plant use. These soils are susceptible to sheet and gully erosion unless protected. The main management needs are the control of erosion, the maintenance or improvement of fertility, and the maintenance of good tilth.

These soils are suited to wheat, grain sorghum, and alfalfa. They are fair producers of bromegrass pasture if good management is followed. Unless proper management and fertility practices are followed, these soils are better suited to native grasses than to tame grasses. Waterways sodded with native grasses are more dependable than waterways sodded with tame grasses. These soils are also suited to native range, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion if the soils are used for crops. Deep-rooted legumes, if used in the cropping system, improve the water intake. Erosion is excessive where residue is plowed under. If residue is incorporated into the surface layer, it helps to increase moisture intake and to control erosion.

CAPABILITY UNIT IIIe-7

This unit consists only of Labette silty clay loam, 2 to 5 percent slopes, eroded. This soil is on uplands. It has an eroded surface layer of heavy silty clay loam and a subsoil of firm silty clay. It is underlain by limestone or shale at depths of 20 to 40 inches.

This soil is medium in fertility. It takes in water slowly. The available water capacity is low to moderate. The stored water is slowly available for plant use. This soil is subject to sheet and gully erosion if not protected. The main management needs are the control of erosion and the maintenance of fertility and good tilth.

This soil is suited to wheat and sorghum. It is also suited to tame and native perennial grasses, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion. Erosion is excessive if residue is plowed under. If residue is incorporated into the surface layer, it helps to increase moisture intake and to control erosion.

CAPABILITY UNIT IIIw-1

This unit consists of deep soils of the Solomon and Osage series. These soils are on low stream terraces and are occasionally flooded. They have a surface layer of silty clay and a subsoil of very firm and extremely silty clay. The slope range is 0 to 1 percent.

The soils in this unit are high in fertility. They take in water slowly and release it slowly for plant use. They are wet and need drainage in wet periods. In dry periods they are droughty and difficult to till. The main management needs are drainage and the maintenance of fertility and good tilth.

These soils are suited to wheat, sorghum, soybeans, and alfalfa. Many alfalfa stands are lost because of wetness. Where an adequate drainage system is installed and maintained, alfalfa is a dependable crop. Wheat, sorghum, and soybeans are the main crops grown. These soils are suited to such tame grasses as fescue and native perennial grasses. They are suited to trees for windbreaks and to development for wildlife habitat.

A system of open ditches and bedding improves surface drainage. Deep-rooted legumes improve the water intake of these soils. Rough plowing in fall helps aerate the soil and helps to control soil blowing in spring.

CAPABILITY UNIT IVe-1

This unit consists only of Dwight silt loam, 1 to 3 percent slopes. This soil is deep and is on uplands. It has a thin surface layer of silt loam and a subsoil of extremely firm silty clay.

This soil is low in fertility. It takes in water slowly and loses much water through runoff. This soil releases water slowly for plant use. It is droughty and difficult to till. It is susceptible to sheet erosion if not protected. The main management needs are control of erosion and maintenance of fertility and good tilth.

This soil is suited to wheat, with an occasional crop of grain sorghum. It is fairly well suited to fescue or western wheatgrass where good management is followed. It is also suited to native range, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in crops. Sweetclover, if used in the cropping system, improves the water intake of the soil. Erosion is excessive where crop residue is plowed under.

CAPABILITY UNIT IVe-2

This unit consists only of Irwin silty clay loam, 3 to 5 percent slopes, eroded. This soil is deep and occurs on uplands. It has an eroded surface layer of heavy silty clay loam and a subsoil of very firm silty clay. There is some mixing of the silty clay subsoil into the plow layer.

This soil is medium in fertility. It takes in water slowly and loses much water through runoff. It releases water slowly for plant use and is difficult to till. Sheet and gully erosion are hazards if the soil is not protected. The main management needs are control of erosion and maintenance of fertility and good tilth.

This soil is suited to production of small grain if it is cultivated. It is only fairly well suited to pasture under good management. Unless proper management and fertility practices are followed, this soil is better suited to native grasses than to tame grasses. Waterways sodded with native grasses are more dependable than waterways sodded with tame grasses. This soil is also suited to native range, to trees for windbreaks, and to development for wildlife habitat.

Terracing, contour farming, and keeping grass in waterways help to control erosion if this soil is cultivated. Deep-rooted legumes, if used in the cropping system, improve the water intake. Erosion is excessive where crop residue is plowed under.

CAPABILITY UNIT IVe-3

This unit consists only of Reading soils, 6 to 12 percent slopes, eroded. This soil is deep and is on short narrow breaks between terraces and flood plains. It has an eroded surface layer of heavy silt loam or silty clay loam and a subsoil of firm silty clay loam. There is some mixing of the silty clay loam subsoil into the plow layer.

This soil is high in fertility. It takes in water well if the surface layer is in good condition. It loses much water through runoff because of the slope. It is susceptible to sheet and gully erosion if not protected. The main management needs are the control of erosion, and the maintenance of fertility and good tilth.

This soil is suited to tame grasses such as bromegrass. It is suited to all commonly grown crops if an effective erosion control program is followed. It is also suited to native range, to trees for windbreaks, and to development for wildlife habitat.

Terracing and contour farming reduce runoff on these slopes and help to control erosion. If this soil is used for bromegrass pasture, erosion is effectively controlled.

CAPABILITY UNIT VIe-1

This unit consists only of the Martin-Gullied land complex. These soils are on uplands. The Martin soils have an eroded surface layer of heavy silty clay loam or silty clay and a subsoil of very firm silty clay. The areas of Gullied land are cut by deep gullies, and the profiles have been largely destroyed. The slope range

These soils take in water slowly and lose much water through runoff. They release water slowly for plant use. They are susceptible to additional sheet and gully erosion if not protected. The chief management needs are control of erosion and maintaining or establishing a vegetative cover.

The Martin-Gullied land complex is suited to native range. It is also suited to trees for windbreaks and to development for wildlife habitat.

Diversion terraces to intersect gullies, if used in conjunction with range reseeding, help to control erosion. Seeding suitable native grasses also helps to control erosion. After reestablishment of grasses, proper range management keeps the native range in good condition. Fencing allows proper stocking and reseeding. Weed and brush control allows the better quality grasses to crowd out the invaders.

CAPABILITY UNIT VIe-2

This unit consists only of the Clime-Sogn complex. This complex is on uplands. The slope gradient is 3 to 25 percent.

The Clime soil is moderately deep. It has a surface layer of silty clay and a subsoil of firm silty clay. The Sogn soil is shallow. It has a surface layer of silty clay loam, which is underlain by limestone.

The soils take in water slowly, and much water is lost through runoff. The available water capacity is low to moderate in the Clime soil and low in the Sogn soil. Most of the areas cannot be tilled to establish grasses. These soils are susceptible to water erosion, especially where the surface soil has been exposed by fire. Gullies have formed in some places, generally on cattle trails. The chief management needs are to control erosion and to maintain and improve desirable range plant species.

The soils in this unit are suited to native range (fig. 16). The vegetation is predominantly mixed tall and mid grasses and such forbs as black sampson. In many overused areas, the desirable plants have been replaced by less desirable plants, such as dropseed and willowleaf sunflower. These soils are also suited to development for wildlife habitat.

Proper range management will keep these native rangelands in good condition. Cross-fencing allows these areas to be properly stocked and grazing to be deferred. Deferred grazing, proper use of the soils, and weed and brush control allow the better quality grasses to crowd out the invaders.

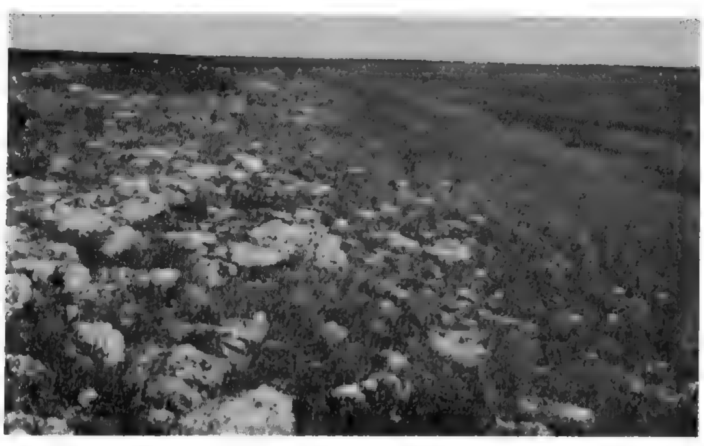


Figure 16.—**A typical area of Clime-Sogn complex. This complex is in capability unit VIe-2.**

CAPABILITY UNIT VIe-3

This unit consists of the Labette-Sogn complex and Florence-Matfield cherty silt loams. These soils are on uplands. The Labette soil is moderately deep. It has a surface layer of silty clay loam and a subsoil of firm silty clay. The Sogn soil is shallow over limestone. It has a surface layer of silty clay loam. Florence and Matfield soils are deep. The Florence soil has a surface layer of cherty silty clay loam and a subsoil of very firm, coarse cherty clay. The Matfield soil has a thick surface layer of cherty silt loam and a subsoil of extremely firm very cherty clay. The slope range is 1 to 15 percent.

These soils take in water well if the surface layer has a good cover. They lose much water through runoff because of the slope. The available water capacity is low for the Sogn, Matfield, and Florence soils. The available water capacity is moderate to low for the Labette soil. Water stored in these soils is readily available for plant use. Most of the soils cannot be tilled to establish grasses. They are susceptible to water erosion, particularly where the surface layer is exposed after fire. The chief management needs are the control of erosion and maintenance and improvement of desirable range species.

These soils are suited to native range. If the range is in excellent condition, most of the soils support tall and mid grasses and forbs, such as leadplant. Many of the gently sloping, shallow, or stony soils have little desirable vegetation. Invaders, such as three-awn, broomweed, and annual bromegrass, have become the main vegetation. These soils are also suited to development for wildlife habitat.

Proper range management keeps these areas of native range in good condition. Cross fencing allows proper stocking and deferred grazing. Proper placing of salt boxes and minerals helps to distribute grazing. Deferred grazing and proper use of the soils allows the better quality grasses to crowd out the invaders.

CAPABILITY UNIT VIe-4

This unit consists of the Olpe-Smolan complex, the Florence-Labette complex, and Tully cherty silty clay loam. These soils are on uplands. The Olpe soil is deep. It has a surface layer of gravelly silt loam and a subsoil of very firm gravelly silty clay. Smolan and Tully soils are deep. They have a surface layer of silty clay loam and a subsoil of very firm silty clay. The Florence soil is deep and has a surface layer of cherty silt loam and a subsoil of very firm, coarse cherty clay. The Labette soil is moderately deep. It has a surface layer of silty clay loam and a subsoil of firm silty clay.

The Olpe and Florence soils are medium in fertility and low in available water capacity. The Labette soil is medium in fertility and moderate to low in available water capacity. The Smolan and Tully soils are medium in fertility and high in available water capacity.

These soils take in water readily if the surface layer has a good cover. Water stored in these soils is readily available for plant use. Most of the soils cannot be tilled

to establish grasses. They are susceptible to water erosion, particularly where the surface has been exposed after annual fires. The chief management needs are to control erosion and to maintain and improve desirable range plants.

The soils in this unit are suited to native range. If the range is in excellent condition, most of the areas support tall and mid grasses and forbs, such as leadplant. These soils are also suited to development for wildlife habitat.

Proper range management keeps these areas of native range in good condition. Cross fencing allows proper stocking and deferred grazing. Proper placing of salt boxes and minerals helps to distribute grazing. Deferred grazing and proper range use allows the better quality grasses to crowd out the invaders.

CAPABILITY UNIT VIw-1

This unit consists of Alluvial land and soils of the Reading series. These soils are on frequently flooded bottom lands and in narrow upland drainageways. Alluvial land includes the mixed gravelly silt loam to silty clay soils along meandering stream channels. Reading soils are deep. They have a surface layer of silt loam and a subsoil of firm silty clay loam. The slope range is 0 to 3 percent.

These soils are high in fertility. They take in water readily. They store large amounts of water, which is readily available for plant use. They are not suited to cultivated crops, because of frequent flooding.

The soils in this unit are used for native range. They are among the most productive range soils in the county. If the range is in excellent condition, this unit supports tall grasses. In some of the areas, the tall grasses have been replaced by bluegrass, spring annuals, small trees, and weeds, such as ironweed. These soils are also suitable for tame pasture and for development of wildlife habitat.

CAPABILITY UNIT VIIe-1

This unit consists only of Stony steep land. It is composed of very shallow soils intermixed with deeper soils and limestone outcrops. The slope range is from 30 to 50 percent.

These soils are fertile. They lose much water through runoff because of the slope. They are susceptible to erosion, especially if the surface soil has been exposed after fire. The main management needs are to control erosion and to maintain and improve desirable range species.

These soils are suited to native range. If the areas are in excellent condition, they produce tall and mid grasses. Many areas now have an overstory of brush and trees. The areas are also suitable for development for wildlife habitat.

Careful grazing management practices are needed to maintain or improve species composition and to control erosion. Fencing separately allows proper stocking and deferred grazing. Aerial spraying, if used in conjunction with proper stocking, deferment of grazing, and occasional burning, helps to control brush and trees. Deferred grazing and proper use allows the high-quality grasses to crowd out the invaders.

Predicted yields

Table 2 gives the predicted average yields per acre of the principal crops—wheat, corn, grain sorghum, sorghum for silage, alfalfa, and tame grass pasture—grown on the soils in capability classes I, II, III, and IV. The yields shown are for two levels of management. They are based on information obtained through interviews with farmers and farm workers. In addition, information was obtained from records of yields from test plots managed in cooperation with the Kansas State University.

Yields to be expected under an average system of management are shown in columns A. This level of management consists of:

1. Use of recommended crop varieties.
2. Proper seeding rates, dates, methods of planting and harvesting.
3. Some use of weed, disease, and insect control practices.
4. Use of starter fertilizer.
5. Limited use of crop residue management.

Yields to be expected under an improved system of management are shown in columns B. This management includes the practices listed for the common level of management, plus the following:

1. A well-planned fertility program that provides for the optimum use of fertilizer and lime required to obtain the best crop yields.
2. Use of such soil and water conserving practices as terraces, contour farming, and grassed waterways.
3. Maximum use of crop residue to aid in control of soil blowing and water erosion, to increase water intake, and to enhance seedling emergence.
4. Use of surface drainage where needed to remove excess water.
5. Use of a well-planned cropping system that fits the operator's needs and maintains the soil in good physical condition.
6. Timely tillage operations.
7. Full and timely use of weed, disease, and insect control practices.

In establishing yields, consideration was given only to crop varieties available when the survey was made. Corn, grain sorghum, and silage yields were based on the use of the better hybrids. Wheat yields were based on selections available and not for hybrid wheat.

Under the sorghum for silage heading, yields are given only for hybrids that produce one crop per growing season. About ten farmers in Chase County are using hybrid sorghums for silage that produce two crops in a given year without reseeding. In the wetter years, yields from these hybrids have produced higher tonnage. Some farmers have produced as much as 40 tons of silage per acre with these varieties under a high level of management.

A few farmers are using hybrid sudan crosses for grazing. On the better soils, such as Reading silt loams, farmers have obtained as high as 400 animal-unit-days grazing per acre.

TABLE 2.—*Predicted average yields per acre for principal nonirrigated crops grown on the arable soils under two levels of management*

[Absence of yield figure indicates that too few acres are used for this crop to give estimated yields. Columns A show yields to be expected under average management, and columns B show yields to be expected under improved management]

Soils	Corn		Grain sorghum		Wheat		Alfalfa		Sorghum for silage		Tame grass pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Tons*	*Tons*	*Tons*	*Tons*	*Animal-unit-days* [1]	*Animal-unit-days* [1]
Chase silty clay loam	55	75	75	90	38	46	4. 0	4. 5	14	25	150	300
Dwight silt loam, 1 to 3 percent slopes			22	36	20	28	1. 0	1. 2			45	90
Irwin silty clay loam, 1 to 3 percent slopes	27	39	39	58	31	40	2. 0	3. 0	8	12	75	150
Irwin silty clay loam, 1 to 3 percent slopes, eroded			28	46	25	30	1. 8	2. 5	6	10	60	120
Irwin silty clay loam, 3 to 5 percent slopes	22	36	33	50	26	32	2. 0	2. 5			75	150
Irwin silty clay loam, 3 to 5 percent slopes, eroded			24	42	20	26	1. 5	2. 0			60	120
Ivan silt loam	39	58	48	65					17	28	180	360
Kahola silt loam	65	90	78	100	42	50	4. 5	5. 0	16	26	150	300
Labette silty clay loam, 1 to 3 percent s lopes	33	45	46	58	31	38	2. 0	3. 0	9	14	90	180
Labette silty clay loam, 3 to 5 percentslopes	29	39	42	54	26	32	1. 8	2. 8	9	14	90	180
Labette silty clay loam, 2 to 5 percent slopes, eroded			35	48	20	28	1. 2	2. 0	6	10	75	150
Labette-Dwight complex, 1 to 3 percent slopes	20	33	33	48	20	28					60	120
Ladysmith silty clay loam, 0 to 1 percent slopes	31	45	42	58	31	40	2. 0	3. 0	10	17	75	150
Ladysmith silty clay loam, 1 to 3 percent slopes	29	43	39	58	31	40	2. 0	3. 0	9	13	75	150
Ladysmith silty clay loam, 1 to 3 percent slopes, eroded			27	46	24	30	1. 8	2. 5			60	120
Martin silty clay loam, 2 to 6 percent slopes	33	52	44	62	28	36	2. 0	3. 0	9	17	90	180
Martin silty clay loam, 2 to 6 percent slopes, eroded			36	55	23	30	1. 5	2. 5	5	10	75	150
Osage silty clay	33	45	45	62	22	32	1. 5	2. 5	9	16	120	240
Reading silt loam, 0 to 1 percent slopes	65	90	78	100	37	48	4. 0	5. 0	14	24	150	300
Reading silt loam, 1 to 3 percent slopes	48	65	66	85	36	44	3. 0	4. 0	12	22	150	300
Reading soils, 6 to 12 percent slopes, eroded					20	32	1. 5	2. 0			90	180
Smolan silty clay loam, 2 to 6 percent slopes	33	45	49	65	32	40	2. 5	3. 5	9	14	90	180
Solomon silty clay	26	40	45	62	24	30	2. 0	3. 0	10	17	120	240
Tully silty clay loam, 3 to 7 percent slopes	33	45	50	68	30	38	2. 0	3. 0	8	16	90	180
Tully silty clay loam, 3 to 7 percent slopes, eroded			40	58	20	30	1. 5	2. 5	7	10	75	150
Zaar silty clay, 3 to 7 percent slopes			40	58	26	34	1. 5	2. 0	5	10	75	150
Zaar-Dwight complex, 1 to 3 percent slopes			30	48	25	34					60	120

[1] Animal-unit-days is a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of days the pasture is grazed during a single grazing season without injury to the sod. An acre of pasture that provides 30 days of grazing for two animals has a carrying capacity of 60 animal-unit-days.

Use of the Soils for Range [4]

Approximately 80 percent, or 403,000 acres, of Chase County is used for range. This rangeland is in all parts of the county. Small tracts of cropland are intermingled with the rangeland in some parts of the county, and most of the cropland is in valleys adjacent to small streams and along the Cottonwood River. Most of the stubble left after crops have been harvested is used for supplemental grazing by livestock. Winter wheat pasture and sudangrass along with the stubble of grain and forage sorghum crops make up about 90 percent of the temporary pasture available to livestock. In addition, about 6,000 acres of perennial cool-season grasses are available for grazing by livestock.

In Chase County the soils formed mainly in material weathered from limestone and interbedded shale. The deeper soils have vegetation that is characteristic of prairie soils. The shallow soils over limestone support mostly mid and short grasses. The calcareous soils that formed in material weathered from shale support vegetation that has a higher percentage of forbs than the other soils. Most of the soils that formed in alluvium are being farmed, but the native vegetation consists mainly of tall grasses, and, along the Cottonwood River and other streams, of tall grasses and trees.

Livestock operations constitute the major enterprises in Chase County. Most of the range is used for feeder and stocker type operations.

As the livestock operations are changed from one class of livestock to another, changes in management must also be made in order to allow the native vegetation to produce its maximum forage potential. Also, a number of major feedlots are operated in the county.

[4] Prepared with the assistance of LEONARD JURGENS, range conservationist, Soil Conservation Service, Emporia.

Range sites and condition classes

Range sites are distinctive kinds of rangeland, each of which produces a significantly different kind and amount of forage or differs in kind of management needed. On natural grasslands, maximum sustained production is obtained from the native vegetation on a range site when it is in climax condition.

Climax vegetation is that combination of native vegetation that expresses the potential productivity of a range site. It is the combination of the most productive plants that can grow and maintain themselves on the site. The climax vegetation is not permanent, but only an expression of the environmental conditions that now exist.

Range condition is the present state of the vegetation as measured against the highest stage of plant growth, or climax vegetation, that the site is capable of producing. Four range condition classes are recognized in determining range condition. These are excellent, good, fair, and poor. Excellent condition means that 76 to 100 percent of the climax vegetation is present on the range site. Good condition means that 51 to 75 percent of the climax vegetation is left. Fair condition means that 26 to 50 percent of the climax vegetation is left. Poor condition means that 25 percent or less of the climax vegetation is present.

Less than excellent condition means that through overgrazing, excessive mowing, or plowing in areas that later revert to range, the potential forage production of the soils has been reduced. During droughts, the effects of overgrazing become apparent and hasten deterioration in range condition. Fortunately, the deterioration process can be reversed. The range can be brought back and maintained in excellent condition by proper management.

Range condition is determined by classifying the plants that grow on each range site. The plants are classified by grouping them into three categories: decreasers, increasers, and invaders. A range site in excellent condition or near climax condition has vegetation that is made up primarily of decreasers and some increasers. Invaders are plants that normally are not present in significant quantities on rangeland that is in excellent condition.

Decreasers are plant species that will be grazed too closely by livestock if the range is overstocked. These are generally the grasses and forbs that are the most productive, as well as the most palatable to livestock. The entire weight of the forage produced by decreaser species is expressed as a percentage and counted for determining range condition.

Increasers are plants that produce some forage under climax conditions. These plants are generally less palatable to livestock, or are plants that escape close grazing by having a shorter growth cycle. By not being grazed as readily as the decreaser plants, increaser plants tend to increase under close grazing at the expense of the decreaser plants. If grazing becomes too severe, increaser plants will also be overgrazed and replaced by invader plants. Only that part of the forage normally produced by increaser species under excellent condition is counted toward the condition rating. The amount allowable is determined by individual species and expressed as a percentage by weight. The percentage allowable depends on the plant species and on the range site on which it is growing.

Invaders are plants that cannot survive under the intense competition of the decreasers and increasers when the range is at or near climax condition. When this competition of the decreasers and increasers is reduced by overgrazing and occasionally by severe drought, these invader plants rapidly appear and fill in the voids in the plant community. Most species of invader plants have little or no grazing value. None of the volume of forage produced by invaders is counted in determining range condition.

While all rangeland needs judicious management of grazing use, some range in poor or fair condition may also need practices that speed up improvement. Practices of this kind that are suitable to some of the range sites and soils of this county include range seeding, brush control, and controlled burning.

Range seeding generally is used to convert existing or former cropland back to grass. Brush control is limited to a relatively small acreage where the less desirable species of brush have substantially increased in number. Controlled burning should be used only if plant residues have accumulated to such an extent that the production is lowered. It is also used at times to aid in suppressing brush.

The need and feasibility of these practices differ by range sites, by soils, and by range condition.

Descriptions of range sites

The native vegetation in Chase County consists mainly of tall and mid grasses and associated forbs and shrubs. The major range site is the Loamy Upland range site, which makes up 38 percent of the total range land. The Claypan range site makes up 17 percent of the range.

The following list is a guide to the amount of forage production that can be expected on the range sites when they are in excellent condition. This list reflects high and low yields; the production in most years is somewhere in between, depending on availability of moisture and vigor of the vegetation. The yield figures represent pounds per acre of total air-dry forage.

Range site	*High* *Lb. per acre*	*Low* *Lb. per acre*
Breaks	6,000	3,500
Claypan	4,000	1,000
Clay Lowland	10,000	3,000
Clay Upland	8,000	2,000
Flint Ridge	3,000	1,000
Limy Upland	4,000	2,000
Loamy Lowland	10,000	6,000
Loamy Upland	6,500	3,500
Shallow Limy	3,500	2,000

The range sites in this county are described on the following pages.

Figure 17 shows the range sites of Chase County and their general position on the landscape.

The names of soil series represented in a range site are given in the description of the range site, but this does not mean that all the soils of a given series are in that site. To find the names of all the soils in any given range site, refer to the "Guide to Mapping Units."

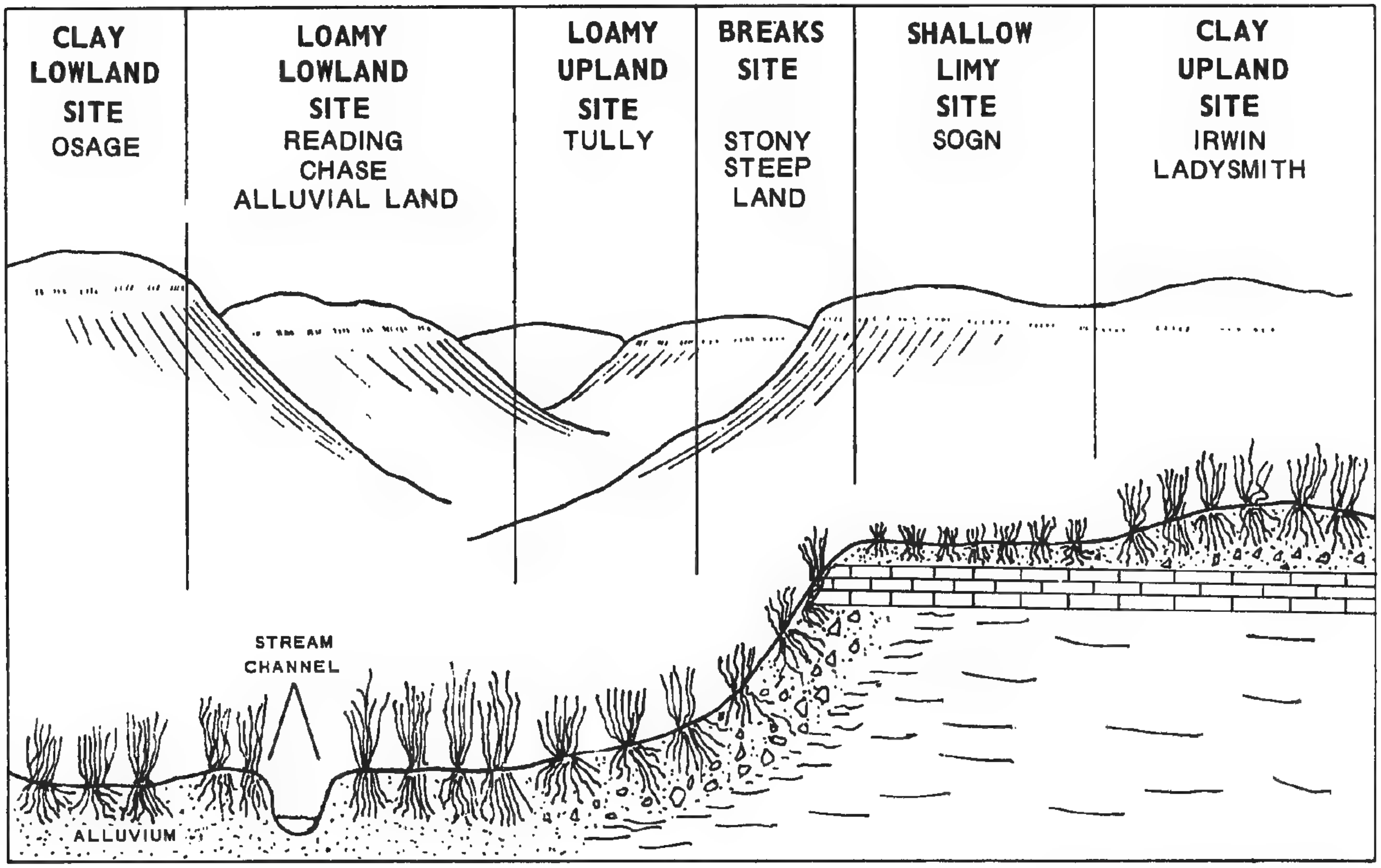


Figure 17.—**The major range sites**

BREAKS RANGE SITE

This range site consists only of Stony steep land. Areas of this range site consist of very shallow soils intermingled with deeper soils and limestone outcrops. The soils are excessively drained, and runoff is rapid. The slope range is 30 to 50 percent. The available water capacity is low to high.

Decreaser grasses, such as big bluestem, little bluestem, indiangrass, prairieclover, jerseytea, and switchgrass, make up about 70 percent of the plant community when this site is in excellent condition. The forb decreasers produce up to 20 percent of the total production. The major increasers are side-oats grama, tall dropseed, blue grama, hairy grama, smooth sumac, and aromatic sumac. The invaders are buckbrush, weed trees, broomweed, and a number of annual forbs.

The average annual production of air-dry forage when this site is in excellent condition is about 4,000 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

The steepness of the slope and the many exposed rocks hamper most management practices. Controlled burning, however, can be used to advantage on this site to obtain distribution of grazing. Chemical brush control is possible with the use of aerial spraying.

CLAYPAN RANGE SITE

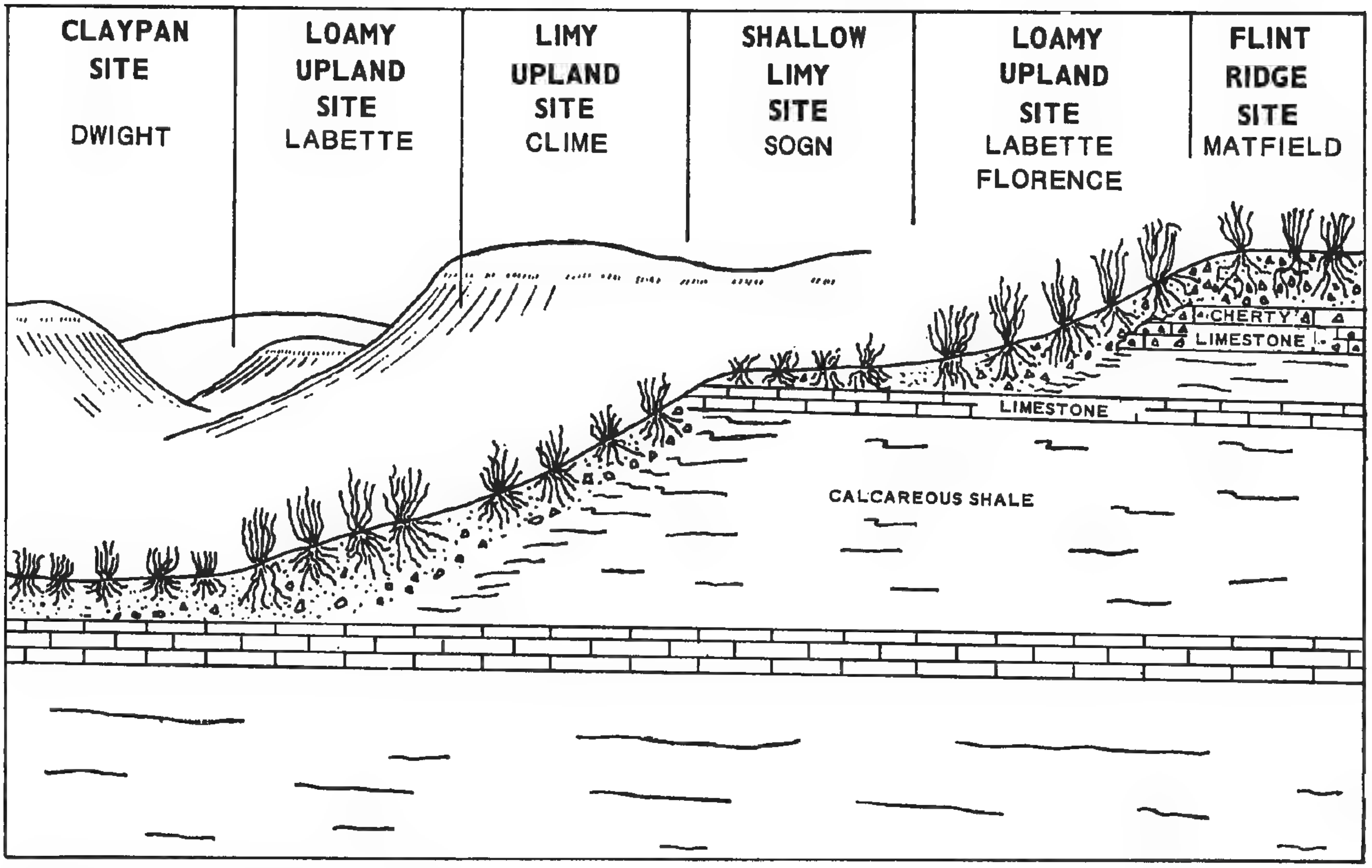
This range site consists of soils of the Dwight series and of eroded Irwin and Ladysmith soils. These are deep, somewhat poorly drained to well-drained soils. The slope range is 1 to 5 percent. The available water capacity is moderate to high. The soils are droughty during periods of low rainfall, however, because the compact subsoil is slow to release water for plant use, and this restricts root development.

Decreaser grasses, such as side-oats grama, switchgrass, and little bluestem, make up about 60 percent of the plant community when this site is in excellent condition. Some increasers on this site are western wheatgrass, blue grama, buffalograss, slimflower scurf-pea, and heath aster. The major invaders are annual three-awn, annual brome, and broomweed. Broomweed, heath aster, annual three-awn, and buffalograss produce most of the vegetation on this site when it is in poor condition.

The average annual production of air-dry forage when this site is in excellent condition is approximately 2,500 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

This range site is frequently overgrazed because of its position in the landscape.

This site responds rather slowly to management. Improvement does not come so rapidly as on most other



and their general position on the landscape.

range sites in this county. Reseeding in "go-back" areas is feasible if the soils can be protected from grazing until the grass cover is well established.

CLAY LOWLAND RANGE SITE

This range site consists of soils of the Osage and Solomon series. These soils are deep and poorly drained. The slope range is 0 to 1 percent. These soils take in water slowly and release it slowly for plant use. They receive additional water from flooding and from run-in from adjacent slopes. When dry, these soils crack and become very hard.

Where these soils are used for range, a network pattern of shallow depressions occurs. When this range site is in excellent condition, these shallow depressions have a high percentage of sedge in addition to prairie cordgrass, which is the major decreaser on this site. In the slightly elevated areas between the depressions, big bluestem, indiangrass, and switchgrass are present along with the prairie cordgrass.

Decreaser grasses, such as prairie cordgrass, big bluestem, indiangrass, and switchgrass, make up about 90 percent of the plant community when this site is in excellent condition. Some increasers on the site are sedges, tall dropseed, western wheatgrass, and ironweed. The major invaders are tumblegrass, annual three-awn, barnyardgrass, weed trees, and Kentucky bluegrass. When this site is in poor condition, tall dropseed, sedge, Osage-orange, barnyardgrass, tumblegrass, and Kentucky bluegrass produce most of the vegetation.

The average annual production of air-dry forage when this site is in excellent condition is approximately 7,500 pounds per acre. Approximately 85 percent of the total annual production provides forage for cattle.

Mechanical practices can usually be performed sometime during the year. Occasional periods of extreme wetness can delay operations for a year or more. If range seeding is done on this site, a cover crop used for 2 years or more will reduce the annual weed competition. Spraying or mowing to control woody vegetation may be needed also to obtain stands of vegetation. On depleted rangeland, brush control is frequently needed.

CLAY UPLAND RANGE SITE

This range site consists of uneroded Irwin, Ladysmith, and Zaar soils and eroded soils of the Labette, Martin, and Tully series. These are deep and moderately deep, somewhat poorly drained to well-drained soils on uplands. The slope range is 0 to 7 percent. All soils in this range site are high in available water capacity except for the eroded Labette soil, which is moderate to low in available water capacity. The soils are droughty dur-

ing periods of low rainfall because the clayey subsoil is slow to release water for plant use. In years of adequate moisture and well-distributed rainfall, this is a highly productive upland range site.

Decreaser grasses make up about 75 percent or more of the plant community. The major decreasers are big bluestem, little bluestem, and leadplant amorpha. The major increasers are switchgrass, side-oats grama, tall dropseed, blue grama, slimflower scurf-pea, and western ragweed. Invaders are annual bromes, annual three-awn, buckbrush, and broomweed.

When this site is in excellent condition, the average annual production of air-dry forage is about 4,700 pounds per acre. Approximately 85 percent of the total annual production provides forage for cattle.

The vegetation on this range site responds readily to management practices, and mechanical practices can be carried out without serious difficulty. Areas in poor condition can be reseeded with the aid of a cover crop.

FLINT RIDGE RANGE SITE

This range site consists only of the Matfield part of the Florence-Matfield complex. Areas of this soil are on uplands. The soil is deep and well drained to somewhat excessively drained. The slope range is 1 to 5 percent. The available water capacity is low, and this soil is droughty. It is usually overgrazed because of its accessibility to livestock.

Decreaser grasses, such as little bluestem, big bluestem, indiangrass, jerseytea, and prairieclover, make up about 75 percent of the plant community when this site is in excellent condition. Some increasers are side-oats grama, hairy grama, and western ragweed. The major invaders are annual bromes, annual three-awn, annual plantain, broomweed, and tumblegrass.

When this site is in poor condition, the vegetation consists mostly of annual bromes, broomweed, hairy grama, western ragweed, and annual plantain. The average annual production of forage when this site is in excellent condition is 2,200 pounds per acre of air-dry forage Approximately 80 percent of the total annual production provides forage for cattle.

The only practical way to improve the range condition is to defer grazing during the growing season. Mechanical practices on this range site are not economical, because of the high amount of chert in the profile, as well as on the surface.

LIMY UPLAND RANGE SITE

This range site consists only of the Clime part of the Clime-Sogn complex. The areas are on uplands. This soil is moderately deep and is moderately well drained to well drained. The slope range is 3 to 25 percent. The available water capacity is low to moderate, but stored water is readily available for plant use.

Decreaser grasses, such as little bluestem, big bluestem, indiangrass, jerseytea, blacksamson, and prairie-clover, make up about 80 percent of the plant community when this site is in excellent condition. Some increasers on this site are side-oats grama, hairy grama, willowleaf sunflower, parthenium, Missouri goldenrod, and dotted gayfeather. The major invaders are annual bromes, broomweed, and annual three-awn. Willowleaf sunflower, hairy grama, Missouri goldenrod, annual bromes, broomweed, and annual three-awn produce most of the vegetation when this range site is in poor condition.

The average annual production of air-dry forage when this site is in excellent condition is about 3,000 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

The forb populations on this site sometimes give concern, and attempts are made to reduce their number. This is rarely necessary on this site. When the forb increasers do become excessive and improvement in range condition is needed, deferred grazing gives the desired result. Chemical spraying or mowing rarely are effective for more than one season. In a few areas, reseeding is necessary and care must be taken that suitable native species are used.

LOAMY LOWLAND RANGE SITE

This range site consists of soils of the Chase, Ivan, Kahola, and Reading series, and of Alluvial land. These soils are on low stream terraces and flood plains. They are deep and somewhat poorly drained to well drained. The slope range is 0 to 2 percent. The available water capacity is high.

This site is seldom in excellent condition, because of its slope and general proximity to watering facilities.

Decreaser grasses make up about 90 percent of the plant community. The major decreasers are big bluestem, indiangrass, switchgrass, eastern gamagrass, wholeleaf rosinweed, compassplant, and sawtooth sunflower. Major increasers are side-oats grama, tall dropseed, sedges, ironweed, buckbrush, and western ragweed. The major invaders are annual bromes, Kentucky bluegrass, and scrub trees.

When this range site is in poor condition, buckbrush, ironweed, western ragweed, barnyardgrass, Kentucky bluegrass, and scrub trees make up most of the vegetation.

When this site is in excellent condition, the average annual production of air-dry forage is approximately 8,000 pounds per acre. Approximately 85 percent of the total annual production provides forage for cattle. This range site produces more forage than any other site in the county when it is in excellent condition.

If the vegetation on this site has deteriorated, brush control may be needed. Spraying or mowing with brush mowers is generally effective. Controlled burning can help to maintain this site in excellent condition. Except for flooding, which may delay seedbed preparation, range seeding can be done readily on this site if a good system of cover crops is used.

After seeding, control of brush and weeds helps the grass to become established. Where feasible, this range site needs to be managed separately from other range sites to obtain consistent long-term yields.

LOAMY UPLAND RANGE SITE

This range site (fig. 18) consists of soils of the Labette, Florence, Martin, Olpe, Smolan, Tully, and sloping soils of the Reading series. These soils are deep and moderately deep, and moderately well drained to well drained. The slope range is 1 to 15 percent. The available water capacity is low to high, but stored water

Figure 18.—**Loamy Upland range site in excellent condition in the foreground. This is an area of Labette soils. The background shows a general view of the "Flint Hills."**

is readily available for plant use. Some soils in this range site have gravel or chert fragments in the surface layer, as well as throughout the profile. These soils are on uplands, except for the Reading soils, which are on stream terraces.

Decreaser grasses make up about 80 percent or more of the total plant community when this site is in excellent condition. The major decreasers are big bluestem, indiangrass, switchgrass, leadplant amorpha, roundhead lespedeza, and prairie-clover. Major increasers are side-oats grama, tall dropseed, blue grama, smooth sumac, and western ragweed. The major invaders are annual bromes, annual three-awn, broomweed, buckbrush, and Kentucky bluegrass. When this site is in poor condition, most of the vegetation is produced by annual bromes, tall dropseed, smooth sumac, broomweed, buckbrush, and Kentucky bluegrass.

The average annual production of air-dry forage when the site is in excellent condition is about 5,000 pounds per acre. Approximately 85 percent of the total annual production provides forage for cattle.

Some areas on this range site are in "go-back" condition and need to be seeded to native vegetation. The seeding can best be done with the use of a cover crop a year before reseeding. Brush control is needed in some areas of this site to control buckbrush, sumac, and weed trees that have become established in excessively used areas. Occasional controlled burning will help to distribute grazing and to maintain range condition, especially on the Florence soils.

SHALLOW LIMY RANGE SITE

This range site (fig. 19) consists only of the Sogn part of the Clime-Sogn complex and the Labette-Sogn complex. The areas are on uplands. The soils are shallow and very shallow and are somewhat excessively drained. The slope gradient is 1 to 12 percent. The available water capacity is low, but stored water is readily available for plant use. In places limestone is exposed on the surface.

Decreaser grasses make up about 60 percent of the plant community when this site is in excellent condition. The principal decreasers are side-oats grama, little bluestem, blacksamson, and prairie-clover. The principal increasers are hairy grama, buffalograss, blue grama, smooth sumac, and in some areas, willowleaf sunflower.

Figure 19.—**An area of Shallow Limy range site in excellent condition. The Chase County State Lake is in the background.**

The invaders consist mostly of annual bromes and broomweed. Broomweed, annual bromes, smooth sumac, willowleaf sunflower, and buffalograss predominate when this range site is in poor condition.

The average annual production of air-dry forage when this site is in excellent condition is about 2,700 pounds per acre. Approximately 80 percent of the total annual production provides forage for cattle.

Brush control is needed when high populations of smooth sumac become established in overgrazed areas. Willowleaf sunflower can best be controlled by deferred grazing in areas where large numbers are present.

Use of the Soils for Woodland and Windbreaks [5]

In this section the soils of Chase County are discussed on the basis of their suitability for woodland and farmstead windbreaks. The soils are placed in three woodland suitability groups and seven windbreak suitability groups. The soil-related factors are rated, and the suitable tree species are listed for each group.

Native woodland and descriptions of woodland suitability groups

There are about 10,600 acres of woodland in Chase County. It occurs mostly as narrow bands and small areas of trees along streams and on some of the steep slopes bordering stream valleys. Many of the stands can produce good sawtimber if properly managed. Woodlands should be protected from fire and grazing and cleared of cull trees and wolf trees.

[5] Prepared with the assistance of F. D. ABBOTT, State soil conservationist, Soil Conservation Service, Salina, and ROY M. DAVIS, area conservationist, Soil Conservation Service, Emporia.

Potential soil productivity for wood crops is expressed as site index, which is the height attained by the average dominant and codominant trees at the age of 50 years. The site index reflects the rate of tree growth, or potential productivity for suitable tree species (7). A woodland suitability group is made up of soils that produce similar kinds of wood crops, that need similar management to produce these crops, and that have about the same potential productivity.

The soils not assigned to woodland suitability groups are not suitable for that use.

The woodland suitability groups for Chase County are discussed in the following paragraphs.

WOODLAND SUITABILITY GROUP 1

The only soil in this group is Ivan silt loam (fig. 20). This is a deep, well drained to moderately well drained, calcareous soil on flood plains. It is frequently flooded, but the flooding is of short duration.

This soil is high in fertility and in available water capacity. It takes in water readily and releases it readily for plant use.

Seedling mortality due to spring flooding is moderate. Loss to drought is slight, and plant competition is severe. Vines and weed trees hinder growth of desirable species, and competition from this source needs to be reduced.

Equipment limitations are slight; only flooding hinders operation of logging and other equipment. Windthrow hazard is slight, and no special precautions are necessary. The erosion hazard is slight. Clean cutting near or

Figure 20.—Stand of walnut and oak sawtimber on Ivan silt loam. This soil is in woodland suitability group 1.

in old or existing stream channels should be avoided to prevent bank erosion.

Soils of this group are good producers. The site index for suitable mixed hardwoods ranges from 50 to 80 for different species. The rating is 65 to 75 for black walnut, hackberry, and green ash; 50 to 60 for bur oak; and 65 to 80 for soft maple. These soils can be expected to produce 170 to 230 board feet per acre annually of black walnut, hackberry, green ash, or soft maple. They can produce 100 to 140 board feet annually of bur oak.

Black walnut, bur oak, soft maple, green ash, hackberry, and sycamore are suitable species.

WOODLAND SUITABILITY GROUP 2

This unit consists of deep soils of the Solomon and Osage series. These are poorly drained soils on low stream terraces. They are subject to occasional flooding.

These soils are high in fertility. They take in water slowly and release it slowly for plant use. They are wet, and drainage is needed in wet periods.

Seedling mortality due to spring flooding and wetness is moderate. Loss of trees because of drought in dry summers is common. Plant competition is severe, and desirable species must meet the competition of grass, weed trees, and vines.

Equipment limitations are severe. Operation of equipment causes soil compaction and injury to roots except during the driest months. The windthrow hazard is severe. The erosion hazard is slight. The stands should be opened slowly, and single trees should not be left.

Soils of this group are fair producers. The native vegetation is mostly open grassland. The site index for suitable mixed hardwood species ranges from about 50 to 60. These soils can be expected to produce 100 to 140 board feet per acre annually of green ash or soft maple.

The erosion hazard is slight. Deposition is common.

Suitable species are soft maple and green ash.

WOODLAND SUITABILITY GROUP 3

This unit consists of deep soils of the Chase, Kahola, and Reading series. These are somewhat poorly drained to well-drained soils on low stream terraces. They are occasionally flooded.

These soils are high in fertility. They have high available water capacity and take in and release water readily for plant use.

Seedling mortality is slight. Soil conditions are favorable for good seedling survival and growth. Plant competition is moderate. Some treatment is needed to remove competition of vines and weed trees.

Equipment limitations are slight; only flooding limits the operation of equipment. The windthrow hazard is slight. The erosion hazard is slight.

The site index ranges from about 65 to 75 for the suitable mixed hardwoods. The rating is 60 to 75 for black walnut, 65 to 75 for green ash and hackberry, and 50 to 60 for bur oak. These soils can produce 170 to 230 board feet per acre annually of black walnut, green ash, and hackberry. They can also produce 100 to 140 board feet annually of bur oak .

Black walnut, bur oak, green ash, and hackberry are suitable species.

Farmstead windbreaks and descriptions of windbreak suitability groups

Farmsteads exposed to cold winter winds and to hot summer winds need the protection of windbreaks. There are many feedlots in the county that need the protection a windbreak can afford. Trees and shrubs for windbreaks should be selected according to their suitability for the soils. Suggestions for suitable species for windbreak plantings are not tied specifically to individual soils or woodland suitability groups, because the site factors involved in managing woodlands are not so strongly limiting under the intensive cultural and management practices used in establishing and managing windbreaks. Many sites that are considered unsuitable for woodland can be used for windbreak planting. All the soils in Chase County can be used for trees suitable for windbreaks if the proper species are selected.

The soils of the county are placed in seven windbreak suitability groups. The names of soil series represented in a group are given in the description, but this does not mean that all the soils of a given series are in that group. To find the names of all the soils in any given group, refer to the "Guide to Mapping Units."

The windbreak suitability groups are discussed in the following pages.

WINDBREAK SUITABILITY GROUP A

This group consists of soils of the Chase, Ivan, Kahola, and Reading series and of Alluvial land. These are deep, somewhat poorly drained to well-drained soils on flood plains and stream terraces. They are subject to flooding. Permeability is moderate to slow. The slope range of the Chase, Ivan, and Kahola soils is 0 to 2 percent. The slope range of the Reading soils is 0 to 12 percent.

Trees and shrubs suitable for planting are—

- Conifers: Austrian pine, shortleaf pine, Scotch pine, and eastern redcedar.
- Tall broadleaf trees (fast growers): Siberian elm, cottonwood, silver maple, and sycamore.
- Tall broadleaf trees (slow to moderate growers): black walnut, bur oak, green ash, hackberry, honeylocust, and pin oak.
- Intermediate broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.
- Shrubs: bush-honeysuckle, lilac, multiflora rose, and American plum.

WINDBREAK SUITABILITY GROUP B

This group consists of soils of the Solomon and Osage series. These are deep, poorly drained soils on low stream terraces. They are subject to occasional flooding. Permeability is very slow. The slope range is 0 to 1 percent.

Trees and shrubs suitable for planting are—

- Conifers: Austrian pine, eastern redcedar, and shortleaf pine.
- Tall broadleaf trees (fast growers): cottonwood, silver maple, and sycamore.
- Tall broadleaf trees (slow to moderate growers): bur oak, green ash, hackberry, honeylocust, and pin oak.

Intermediate broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.
Shrubs: bush-honeysuckle, lilac, multiflora rose, and American plum.

WINDBREAK SUITABILITY GROUP C

This group consists of soils of the Irwin, Ladysmith, Labette, Martin, Smolan, and Tully series. All of these soils are deep, except the Labette soils, which are moderately deep. These soils are somewhat poorly drained to well drained and are on uplands. Permeability is slow to very slow. The slope range is 0 to 15 percent.

Trees and shrubs suitable for planting are—

Conifers: Austrian pine, shortleaf pine, Scotch pine, and eastern redcedar.
Tall broadleaf trees (fast growers): Siberian elm, cottonwood, silver maple, and sycamore.
Tall broadleaf trees (slow to moderate growers): bur oak, green ash, hackberry, honeylocust, and pin oak.
Intermediate broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.
Shrubs: fragrant sumac, gray dogwood, bush-honeysuckle, lilac, multiflora rose, and American plum.

WINDBREAK SUITABILITY GROUP D

This group consists of soils of the Clime series. These are moderately deep, moderately well drained to well drained soils on uplands. Permeability is moderately slow. The slope range is 3 to 25 percent.

Trees and shrubs suitable for planting are—

Conifers: eastern redcedar and Austrian pine.
Tall broadleaf trees (slow to moderate growers): bur oak, honeylocust, green ash, hackberry, and Siberian elm.
Intermediate broadleaf trees: Osage-orange, Russian mulberry, and Russian-olive.
Shrubs: bush-honeysuckle, lilac, multiflora rose, American plum, fragrant sumac, and gray dogwood.

WINDBREAK SUITABILITY GROUP E

This group consists of soils of the Dwight and Zaar series and eroded soils of the Irwin and Ladysmith series. These are deep, somewhat poorly drained to well-drained soils on uplands. Permeability is very slow. The slope range is 1 to 7 percent.

Trees and shrubs suitable for planting are—

Conifers: eastern redcedar.
Tall broadleaf trees (slow to moderate growers): pin oak.
Intermediate broadleaf trees: Osage-orange.
Shrubs: fragrant sumac.

WINDBREAK SUITABILITY GROUP F

This group consists of soils of the Florence, Olpe, and Tully series and of Stony steep land. These are well-drained soils on uplands. Permeability is moderately slow to very slow. The slope range is 2 to 15 percent, except in Stony steep land, where it is 30 to 50 percent.

Trees and shrubs suitable for planting are—

Conifers: eastern redcedar, Austrian pine, Scotch pine, and shortleaf pine.
Tall broadleaf trees (slow to moderate growers): bur oak and honeylocust.
Intermediate broadleaf trees: Osage-orange.
Shrubs: fragrant sumac, gray dogwood, and American plum.

WINDBREAK SUITABILITY GROUP G

This group consists of soils of the Matfield and Sogn series. Matfield soils are deep, but Sogn soils are shallow. Both soils are on uplands. Matfield soils are well drained to somewhat excessively drained and are very slowly permeable. Sogn soils are somewhat excessively drained and moderately permeable. The slope range is 1 to 12 percent.

Trees and shrubs suitable for planting are—

Conifers: eastern redcedar.
Intermediate broadleaf trees: Osage-orange.
Shrubs: fragrant sumac and gray dogwood.

Use of the Soils for Wildlife

The soils of Chase County produce high-quality native grasslands, which in turn produce high-quality livestock products. The county also supports a large population of prairie chickens. These birds find habitat primarily in the Florence-Labette and Clime-Sogn associations. These soils are in native range. Overgrazing and indiscriminate burning in these associations are detrimental to the wildlife habitat.

White-tailed deer find habitat throughout the county, primarily in the Reading-Tully and Chase-Osage associations. Under modern game management techniques, the deer in the county have recovered from near extinction to the present surplus available for hunting purposes. Mule deer, though fewer in number, share the same habitat as the white-tailed deer.

Pheasant populations are sparse in Chase County. These birds are on the eastern border of their range within the State of Kansas. Pheasant prefer a habitat made up primarily of cultivated areas. The Labette-Irwin and Reading-Tully associations provide the variations in food and cover necessary for this game bird.

Bobwhite quail are found in moderate to high numbers throughout the county. Essential items of good quail habitat include brushy areas, food sources, and herbaceous nesting cover. These are available on all soil associations, but the better habitat is in the Labette-Irwin, Reading-Tully, Chase-Osage, and Ladysmith-Martin associations.

Furbearers, such as muskrats, mink, beaver, and raccoon, live near creeks, rivers, and lakes. The Chase-Osage and Reading-Tully associations support the greatest number of these animals. Other furbearers, such as skunk, civit, opossum, badger, fox, and coyote, occur in all soil associations where some woody cover is present.

Farm ponds constructed for the purpose of providing livestock watering places or fishing grounds are located throughout the county, although care must be exercised in the selection of sites within the Florence-Labette and

[6] By JACK W. WALSTROM, biologist, Soil Conservation Service, Salina.

Clime-Sogn associations. Seepage can cause ponds to dry up during periods when they are most needed for livestock and wildlife. Several large springs provide clear, pure water that can be used to support a small cold-water fish hatchery or rearing ponds (fig. 21). The permanent streams and rivers support a warm-water fishery for bass and other sunfish, walleye catfish, and bullheads, as well as carp and other rough fish (fig. 22). Pollution from feedlots and soil erosion restrict game fish populations.

Figure 21.—**Permanent all-season spring suitable for development for trout. All-season water temperature is 56° F. These springs are in an area of Labette-Sogn complex.**

Table 3 presents the potential of the soil associations shown on the general soil map for producing habitat needed by different kinds of wildlife in Chase County. The ratings of very good, good, and fair take into account the kinds of soil and their characteristics with respect to potential for producing the kind of habitat needed for fish and wildlife.

Open-land wildlife consists of animals that normally inhabit croplands, pastures, meadows, and odd areas of herbaceous vegetation. These animals include pheasant, quail, prairie chickens, meadowlarks, cottontail rabbits, coyote, and badger.

Woodland wildlife consists of animals that normally inhabit wooded areas or require more of this kind of cover intermixed with other kinds. These animals include white-tailed deer, squirrel, raccoon, and thrushes.

Wetland wildlife consists of animals that normally inhabit wet areas, such as ponds, marshes, rivers, streams, and swamps. These animals include ducks, shore birds, beaver, fish, mink, and muskrat.

There are about six rookeries of great blue heron in Chase County. These rookeries are primarily along streams in the Reading-Tully association. The herons nest in large sycamore and cottonwood trees.

Developing habitat for wildlife requires proper location and distribution of vegetation. Technical assistance in planning wildlife developments and determining which species of vegetation to use can be obtained at the local office of the Soil Conservation Service in Cottonwood Falls. Additional information and assistance can be obtained from the Kansas Forestry, Fish and Game Commission, Bureau of Sport Fisheries and Wildlife.

Figure 22.—**Permanent clear-water streams on South Fork of Cottonwood River. Such streams are suitable for development and management for bass, channel catfish, and other species.**

TABLE 3.—*Potential of soil associations for producing elements of habitat required for various kinds of wildlife*

Soil association	Kinds of wildlife	Potential for producing different elements of habitat			
		Woody plants	Herbaceous cover	Food	Water [1]
Labette-Irwin and Ladysmith-Martin.	Open-land	Good	Good	Good.	
	Woodland	Fair	Good	Fair.	
Florence-Labette and Clime-Sogn.	Open-land	Good	Very good	Good.	
Reading-Tully.	Open-land	Good	Good	Good.	
	Woodland	Very good	Good	Good.	
	Wetland	Very good	Good	Good	Good.
Chase-Osage.	Open-land	Good	Good	Good.	
	Woodland	Good	Good	Good.	
	Wetland	Very good	Very good	Very good	Good

[1] Applies only to wetland kinds of wildlife.

Management of the Soils for Recreation [7]

Chase County is accessible to recreation seekers by two major highways. U.S. Highway 50 crosses the county in an east-west direction, and Interstate 35, which connects Wichita and Topeka, crosses the southeastern corner of the county. Also, State Highway 177 runs north and south through the county.

Table 4 gives the degree of limitation and soil features affecting use of the soils for recreation.

The ratings given in table 4 are slight, moderate, and severe. A rating of slight means that the soil has few or no limitations for the use specified or that the limitations can be easily overcome. A rating of moderate indicates that some planning and engineering practices are needed to overcome the limitations. A rating of severe indicates that the soil is poorly suited to the use specified and that intensive engineering practices are needed to overcome the limitations. The soil texture given in the table is that of the surface layer.

Intensive campsites are areas to be used for tents and small camp trailers and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and leveling for tent and parking areas. The soils should be suitable for heavy foot traffic and for limited vehicular traffic. Soil suitability for growing and maintaining vegetation should be considered separately in final evaluation of a site.

Under the heading for picnic areas, the ratings are based on soil features only. Such other features as the proximity of lakes and trees may affect desirability of the site.

[7] By JACK W. WALSTROM, biologist, Soil Conservation Service, Salina.

TABLE 4.—*Degree of limitation and soil features affecting use of the soils for recreation*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table]

Soil series and map symbols	Intensive campsites	Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Alluvial land and Reading soils: Ar.	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding.
Chase: Ch	Moderate: slow permeability.	Moderate: silty clay loam texture.	Severe: slow permeability; silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.
*Clime: Cs. For Sogn part of Cs, refer to Sogn series.	Moderate: moderately slow permeability.	Moderate: slope is 3 to 18 percent.	Severe: slope is 3 to 18 percent.	Moderate: silty clay texture.	Severe: silty clay texture.
Dwight: Dw	Severe: very slow permeability.	Moderate: moderately well drained.	Severe: very slow permeability.	Severe: very slow permeability.	Severe: very slow permeability.

TABLE 4.—*Degree of limitation and soil features affecting use of the soils for recreation*—Continued

Soil series and map symbols	Intensive campsites	Picnic areas	Intensive play areas	Trails and paths	Golf fairways
*Florence: Fa, Fm. For Labette part of Fa, see Labette series. For Matfield part of Fm, see Matfield series.	Moderate: slope is 3 to 15 percent.	Moderate: slope is 3 to 15 percent.	Severe: slope is 3 to 15 percent.	Moderate: cherty silt loam texture.	Moderate: cherty silt loam texture.
Irwin: Ic, In, Ir, Is	Severe: very slow permeability.	Moderate: silty clay loam texture.	Severe: very slow permeability.	Moderate: silty clay loam texture.	Moderate: very slow permeability.
Ivan: Iv	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding	Severe: flooding.
Kahola: Ka	Slight	Slight	Slight	Slight	Slight.
*Labette: La, Lb, Lc, Ld, Le. For Dwight part of Ld, see Dwight series. For Sogn part of Le, see Sogn series.	Moderate: slow permeability.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: slow permeability.
Ladysmith: Lm, Lo, Ls	Severe: very slow permeability.	Moderate: silty clay loam texture.	Severe: very slow permeability.	Moderate: silty clay loam texture.	Moderate: very slow permeability.
Martin:					
Ma, Mc	Moderate: slow permeability.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: slow permeability.
Mg	Severe: deep gullies.	Severe: deep gullies.	Severe: deep gullies.	Severe: deep gullies.	Severe: deep gullies.
Matfield. Mapped only with Florence soils.	Moderate: cherty silt loam texture.	Moderate: cherty silt loam texture.	Severe: slope is 1 to 5 percent; cherty silt loam texture.	Moderate: cherty silt loam texture.	Moderate: cherty silt loam texture.
*Olpe: Om. For Smolan part of Om, see Smolan series.	Moderate: slope is 2 to 10 percent.	Moderate: gravelly silt loam texture.	Severe: slope is 2 to 10 percent.	Moderate: gravelly silt loam texture.	Moderate: gravelly silt loam texture.
Osage: Os	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Reading: Ra, Rd, Re	Slight	Slight	Slight	Slight	Slight.
Smolan: Sm	Moderate: slow permeability.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: silty clay loam texture.	Moderate: slow permeability.
Sogn. Mapped only with Clime and Labette soils.	Severe: shallow soil; rock outcrops.	Severe: shallow soil; rock outcrops.	Severe: shallow soil; rock outcrops.	Severe: shallow soil; rock outcrops.	Severe: shallow soil; rock outcrops.
Solomon: So	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.	Severe: poorly drained.
Stony steep land: St	Severe: slope is 30 to 50 percent.	Severe: slope is 30 to 50 percent.	Severe: slope is 30 to 50 percent.	Severe: slope is 30 to 50 percent.	Severe: slope is 30 to 50 percent.
Tully: Tc, Ts, Tu	Moderate: slow permeability.	Moderate to severe: slope is 3 to 15 percent.	Moderate to severe: slope is 3 to 15 percent.	Moderate: silty clay loam texture.	Moderate: slow permeability.
*Zaar: Za, Zd. For Dwight part of Zd, see Dwight series.	Severe: silty clay texture.	Severe: silty clay texture.	Severe: silty clay texture.	Severe: silty clay texture.	Severe: silty clay texture.

The heading for intensive play areas includes playgrounds for such activities as baseball, football, badminton, and other organized games. Areas should have a nearly level, rock-free surface and good drainage. It is assumed that good vegetative cover can be established and maintained where needed.

The heading for trails and paths includes the use of the soils for local and cross-country footpaths and trails and for bridle paths. It is not anticipated that the soils will have to be graded and shaped to any great extent. Ratings are based on soil features only and do not take into consideration other factors that are important in selection of a site for recreational use.

Under the heading for golf fairways, the ratings are based on soil features only. It is not anticipated that the soils would have to be graded or shaped to any great extent. Areas used for golf fairways need to be smooth and free of stones so that the grass can be mowed. The suitability of the soils for growing and maintaining vegetation was considered in preparing the ratings. Areas used for golf fairways should not be subject to flooding and should not be poorly drained.

Engineering Uses of the Soils [8]

This section provides information of special interest to engineers and others who use soil as structural material or as foundation material upon which structures are built. It gives information on those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties most important in engineering are permeability, shear strength, density, shrink-swell potential, available water capacity, grain-size distribution, plasticity, and reaction.

Information concerning these and related soil properties is furnished in tables 5, 6, and 7. Table 5 gives test data from selected soils in the county, table 6 gives estimated properties of the soils, and table 7 gives engineering interpretations.

The estimates and interpretations of soil properties given in this section can be used in—

1. Planning agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soil.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational sites.

The engineering interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, however, the soil map is useful in planning more detailed field investigations and for indicating the kinds of problems that may be expected.

Some terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms as they are used in soil science.

Engineering classification systems

The two systems most commonly used in classifying samples of soil horizons for engineering purposes are the AASHO system, adopted by the American Association of State Highway Officials (*1*), and the Unified system, used by the Soil Conservation Service, the Department of Defense, and others (*14*).

The AASHO system is used to classify soils according to those properties that affect use in highway construction. In this system, soils are placed in seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for road fill, and in group A–7 are clayey soils that have low strength when wet, or the poorest soils for road fill. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are subdivided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. If soil material is near a classification boundary, it is given a symbol showing both classes; for example, A–2 or A–4. The estimated classification for all soils mapped in the county is given in table 6.

In the Unified system, soils are classified according to particle-size distribution, plasticity, and liquid limit (*11*). In this system, soils are identified as coarse grained (GW, GP, GM, GC, SW, SP, SM, and SC); fine grained (ML, CL, OL, MH, CH, and OH); or highly organic (Pt). Soils on the borderline between two classes are designated by symbols for both classes; for example, CH–MH.

Engineering test data

Table 5 contains the results of engineering tests performed by the State Highway Commission of Kansas on several soils in Chase County.

The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

Maximum dry density is the maximum unit dry weight of the soil when it has been compacted with optimum moisture by the prescribed method of compaction. The moisture content that gives the highest dry unit weight is called the optimum moisture content for the specific method of compaction.

Mechanical analysis shows the percentages, by weight, of soil particles that pass sieves of specified sizes. Sand and other coarser material do not pass the No. 200 sieve. Silt is that material larger than 0.002 millimeter in diameter that passes the No. 200 sieve, and clay is that fraction smaller than 0.002 millimeter in diameter that passes the No. 200 sieve. The clay fraction was determined by the hydrometer method, rather than by the pipette method most soil scientists use in determining the clay in soil samples.

[8] By Roy N. Selby, civil engineer, Soil Conservation Service.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from a semisolid to a plastic state, and the liquid limit is the moisture content at which the material changes from a plastic to a liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Estimated engineering properties of the soils

Table 5 gives estimates of soil properties important in engineering. The estimates are based on field classification and descriptions, test data given in table 5, test data from comparable soils in adjacent areas, and on detailed experience working with the individual kinds of soil in Chase County.

The kind of bedrock is not given in this table. Most of the soils in the county are underlain by limestone and shale. The depth to rock and shale vary widely within short distances and can be a problem where foundation construction to bedrock is of engineering importance.

Although depth to the water table is not important in this county, some of the soils have a slowly permeable subsoil, which causes the surface layer to be temporarily saturated during extremely wet seasons. At sites where there is a fluctuating or high water table, further study and onsite investigation are needed before any engineering structures are designed. Osage and Solomon soils are poorly drained, and in excessively wet times a high water table occurs in some places. Ivan soils are subject to frequent flooding.

The USDA texture is determined by the relative proportions of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. Sand, silt, clay, and other terms used in the USDA textural classification are defined in the Glossary.

Permeability, as used in table 6, relates only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimated permeability rate in inches per hour is based on soil structure and porosity. Plowpans, surface crusts, and other properties resulting from use of soils are not considered.

Available water capacity is that amount of capillary water in the soil available to plants after all free water has drained away. The estimates given are in inches of moisture per inch of soil depth.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The values listed in this column are estimates and are, therefore, expressed as a range. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Shrinking and swelling of soil causes much damage to building foundations, roads, and other structures. The shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. In this table the shrink-swell potential of the soils is rated low, moderate, or high. A high shrink-swell potential indicates a hazard to the maintenance of structures constructed in, on, or with such materials. A high rating means that the soils have a shrink-swell potential of 10 to 15 percent.

A moderate shrink-swell potential indicates a moderate hazard to the maintenance of structures built in, on, or with such materials. These soils commonly have a range of shrink-swell potential of 10 to 20 percent. A low shrink-swell potential indicates a slight hazard to the maintenance of structures constructed in, on, or with such materials. These soils commonly have a range of shrink-swell potential of 10 to 30 percent.

Engineering interpretations

Table 7 gives information useful to engineers and others who plan to use soil material in construction of highways, farm facilities, buildings, and sewage disposal systems. The ratings and interpretations in this table are based on estimated engineering properties given in table 6; on available test data, including those in table 5; and on field experience. The table lists specific features of the soils that affect the selection, design, or application of engineering works. Generally, only detrimental or undesirable features are listed, but some desirable features are also listed.

Topsoil is a term used to designate a fertile soil or soil material, ordinarily rich in organic matter, used to topdress lawns, gardens, roadbanks, and the like. The ratings of good, fair, or poor are for the whole profile, unless a specific soil horizon is named.

There are no sand deposits in the county. Only three soils contain dirty gravel usable for road surfacing; these are Florence cherty silt loam, Matfield cherty silt loam, and Olpe gravelly silt loam. No consideration is given to total quantity or to the quality of the material for specific engineering uses.

Good, solid limestone ledges crop out in many areas of the county. This material makes excellent road-surfacing material when crushed. The Threemile Limestone and the Cottonwood Limestone furnish some of the best building material available in the State.

In the columns for road subgrade and road fill, the ratings are based on the qualities of disturbed soil material borrowed for those uses.

In the highway location column the ratings are based on those features of the soil inplace that affect performance for the geographic location of highways. The entire profile is evaluated, based on the undisturbed soil, without artificial drainage, but with the organic surface layer removed.

In the dikes and levees column, the ratings show the expected behavior of soil material borrowed for low-height and low-hazard embankments.

In the farm pond reservoir area column are listed those soil features that affect the seepage rate of water through undisturbed soils in impoundment areas.

In the column for farm pond embankments are those features and qualities of disturbed soils that affect their suitability for use as earth fill. Both the subsoil and substratum are evaluated where they have adequate thickness for use as borrow material.

Agricultural drainage factors are those features and qualities of the soil that affect the installation and performance of surface and subsurface drainage practices.

Features affecting irrigation capability are moisture intake rate, available water capacity, soil depth, internal drainage, and surface topography.

In the columns for terraces and diversions are considered those features that affect stability or hinder layout and construction. Also considered are sedimentation in channels and difficulty of establishment and maintenance of cover on diversions.

Grassed waterways are affected by those factors that hinder layout and construction and that affect the establishment, growth, and maintenance of plant cover.

In the foundations for low buildings column are listed

TABLE 5.—*Engineering*

[Tests performed by Kansas State Highway Commission, in cooperation with the Bureau of Public Roads, U.S. Department

Soil name and location	Parent material	Report No. S66–Kans.	Depth from surface	Moisture-density data [1]	
				Maximum dry density	Optimum moisture
			Inches	*Lb. per cu. ft.*	*Percent*
Chase silty clay loam: 990 feet S. and 2,225 feet E. of middle of sec. 22, T. 19 S., R. 7 E. (Modal)	Alluvium.	09–6–1	8–14	99	20
		09–6–2	20–42	98	22
		09–6–3	64–84	101	22
Clime silty clay: 1,485 feet S. and 1,560 feet W. of the NE. corner of sec. 30, T. 18 S., R. 8 E. (Modal)	Calcareous shale.	09–1–1	0–10	98	23
		09–1–2	10–22	104	18
		09–1–3	22–33	108	19
Osage silty clay: 50 feet S. and 50 feet E. of NW. corner of the NE¼ sec. 34, T. 19 S., R. 7 E. (Modal)	Alluvium.	09–8–1	8–21	94	24
		09–8–2	21–45	92	26
		09–8–3	63–82	98	22
Reading silt loam: 1,400 feet E. and 2,390 feet N. of the SW. corner of sec. 17, T. 18 S., R. 7 E. (Modal)	Alluvium.	09–4–1	8–17	99	20
		09–4–2	26–41	100	20
		09–4–3	75–84	104	19

[1] Based on AASHO designation T 99–57, Method A (*1*) with the following variations: (1) all material is ovendried at 230° F. and crushed in a laboratory crusher, and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analysis according to AASHO Designation T 88–57 with the following variations: (1) all material is ovendried at 230° F. and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure frequently differ somewhat from results that would have been obtained by the soil survey procedures of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analysed by the hydrometer

those features of an undisturbed soil, to a depth of approximately 5 feet, that affect the suitability of the soil for supporting low buildings with normal foundation loads.

In the septic tank filter field column, the ratings are based on those features of the undisturbed soil that limit the absorption of effluent. Three ratings are given—slight, moderate, and severe.

In the sewage lagoons column, the soils are rated according to their capacity to hold sewage for the time required for bacterial decomposition. The ratings are slight, moderate, and severe.

test data

of Commerce, in accordance with standard procedures of the American Association of State Highway Officials (AASHO)]

Mechanical analysis data [2]							Liquid limit	Plasticity index	Classification	
Percentage passing sieve [3]			Percentage smaller than—						AASHO	Unified [4]
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
							Percent			
100	100	94	88	67	37	27	41	19	A-7-6(12)	CL
100	100	95	90	73	44	37	50	28	A-7-6(17)	CL-CH
100	100	98	95	73	40	34	47	27	A-7-6(16)	CL
100	94	82	77	64	47	34	46	20	A-7-6(13)	ML-CL
100	99	94	90	80	59	43	41	18	A-7-6(11)	CL
100	96	88	84	69	43	29	37	16	A-6 (10)	CL
100	100	96	92	78	54	46	59	35	A-7-6(20)	CH
100	100	97	94	81	58	50	64	38	A-7-6(20)	CH
100	100	96	91	75	49	39	56	33	A-7-6(19)	CH
100	100	95	88	60	32	24	38	16	A-6 (10)	CL
100	100	97	91	68	37	32	45	25	A-7-6(15)	CL
100	100	97	93	70	37	30	42	23	A-7-6(12)	CL

method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analysed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soils.

[3] None of the samples contained coarse fragments greater than 3 inches in diameter.

[4] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given a borderline classification. An example of a borderline classification is ML-CL.

TABLE 6.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils for referring to other series that appear in the first column of this table.

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification: USDA texture	Unified	AASHO
Alluvial land and Reading soils: Ar. Properties too variable to be estimated.					
	Feet	*Inches*			
Chase: Ch	>5	0–20	Silty clay loam	CL	A–7
		20–46	Silty clay	CH or CL	A–7
		46–60	Silty clay	CH	A–7
*Clime: Cs. For properties of Sogn part of Cs, see Sogn series.	2–3. 5	0–18	Silty clay	CL or ML–CL	A–7
		18–33	Silty clay	CL or CH	A–6 or A–7
		33	Shale.		
Dwight: Dw	3. 5–5. 0	0–5	Silt loam	ML or ML–CL	A–4
		5–42	Silty clay	CH	A–7
		42	Limestone.		
*Florence: Fa, Fm. For properties of Labette part of Fa, see Labette series. For Matfield part of Fm, see Matfield series.	3. 5–5. 0	0–13	Cherty silt loam	GC or SC	A–2 or A–6
		13–20	Cherty silty clay loam	GC or SC	A–2 or A–6
		20–42	Coarse cherty clay	GC, SC or CH	A–2 or A–7
		42	Cherty limestone.		
Irwin: Ic, In, Ir, Is	>5	0–11	Silty clay loam	CL	A–6
		11–60	Silty clay	CH	A–7
Ivan: Iv	>5	0–17	Silt loam	CL or ML–CL	A–6
		17–32	Silt loam	CL	A–6
		32–60	Silt loam	CL or ML–CL	A–6 or A–7
Kahola: Ka	>5	0–17	Silt loam	CL or ML–CL	A–6
		17–25	Silty clay loam	CL	A–6
		25–35	Silt loam	CL or ML–CL	A–6
		35–60	Loam	CL or ML–CL	A–6
*Labette: La, Lb, Lc, Ld, Le. For properties of Dwight part of Ld, see Dwight series. For properties of Sogn part of Le, see Sogn series.	2–3. 5	0–15	Silty clay loam	CL or ML–CL	A–6
		15–38	Silty clay	CH	A–7
		38	Limestone.		
Ladysmith: Lm, Lo, Ls	>5	0–9	Silty clay loam	CL	A–6
		9–37	Silty clay	CH	A–7
		37–60	Silty clay loam	CH	A–7
Martin: Ma, Mc	>5	0–15	Silty clay loam	CL	A–7
		15–29	Silty clay	CH	A–7
		29–60	Silty clay	CH	A–7
Martin-Gullied land complex: Mg. Properties too variable to be estimated.					
Matfield. Mapped only in a complex with Florence soils.	>5	0–22	Cherty silt loam	GM or SM	A–4 or A–2
		22–46	Very cherty silt loam	GM or SM	A–4 or A–2
		46–60	Very cherty clay	GC, SC, or CH	A–2 or A–7
*Olpe: Om. For properties of Smolan part of Om, see Smolan series.	>5	0–9	Gravelly silt loam	CL	A–4
		9–18	Gravelly clay loam	SC or GC	A–2 or A–6
		18–60	Gravelly silty clay	GC	A–2 or A–7
Osage: Os	>5	0–45	Silty clay	CH	A–7
		45–60	Silty clay	CH	A–7
Reading: Ra, Rd, Re	>5	0–17	Silt loam	CL or ML–CL	A–6
		17–40	Silty clay loam	CL	A–7
		40–60	Silty clay loam	CL	A–7
Smolan: Sm	>5	0–19	Silty clay loam	CL	A–6
		19–42	Silty clay	CH	A–7
		42–60	Silty clay	CH	A–7

See footnotes at end of table.

significant in engineering

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions The symbol > means greater than; the symbol < means less than]

Percentage less than 3 inches passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction	Shrink-swell potential
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	95–100	90–95	0.20–0.63	0.17–0.19	5.6–6.4	Moderate.
100	100	95–100	90–95	0.06–0.20	0.17–0.19	5.6–7.3	High.
100	100	95–100	85–95	0.06–0.20	0.17–0.19	6.1–7.8	High.
100	100	90–100	80–95	0.20–0.63	0.17–0.19	7.4–8.4	Moderate to high.
100	100	95–100	70–95	0.20–0.63	0.17–0.19	7.4–8.4	Moderate to high.
100	100	90–100	70–90	0.20–0.63	0.16–0.18	5.6–7.3	Low.
100	100	90–100	75–95	<0.06	0.17–0.19	6.1–8.4	High.
[1] 30–65	25–60	20–55	20–50	0.63–2.00	0.06–0.08	5.1–7.3	Low.
[2] 30–65	25–60	20–55	20–50	0.20–0.63	0.06–0.08	5.1–7.3	Low.
[2] 30–70	25–65	20–60	15–55	0.01–0.20	0.04–0.06	5.6–7.3	Low.
100	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–7.3	Moderate.
100	100	95–100	90–95	<0.06	0.17–0.19	5.6–8.4	High.
100	100	90–100	70–90	0.63–2.00	0.17–0.19	7.4–8.4	Moderate.
100	100	90–100	70–90	0.63–2.00	0.17–0.19	7.9–8.4	Moderate.
100	100	95–100	85–95	0.63–2.00	0.17–0.19	7.9–8.4	Moderate.
100	100	90–100	70–90	0.63–2.00	0.17–0.19	6.1–7.8	Moderate.
100	100	90–100	85–95	0.63–2.00	0.17–0.19	6.6–8.4	Moderate.
100	100	90–100	70–90	0.63–2.00	0.17–0.19	7.4–8.4	Moderate.
100	100	85–95	60–75	0.63–2.00	0.16–0.18	7.4–8.4	Moderate.
100	100	90–100	70–80	0.20–0.63	0.17–0.19	5.6–6.5	Moderate.
100	100	95–100	90–95	0.06–0.20	0.17–0.19	5.6–8.4	Moderate to high.
100	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–7.3	Moderate.
100	100	95–100	90–95	<0.06	0.17–0.19	5.6–8.4	High.
100	100	95–100	85–95	0.20–0.63	0.17–0.19	6.6–8.4	Moderate.
100	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–6.5	Moderate.
100	100	95–100	90–95	0.06–0.20	0.17–0.19	6.1–7.3	High.
100	100	95–100	90–95	0.06–0.20	0.17–0.19	6.6–8.4	High.
[1] 30–65	25–60	20–55	15–50	0.20–0.63	0.06–0.08	5.6–6.5	Low.
[2] 30–65	25–60	20–55	15–50	0.20–0.63	0.06–0.08	5.6–7.3	Low.
[2] 30–70	25–65	20–60	15–55	<0.06	0.04–0.06	6.1–7.3	Low.
70–100	65–95	65–95	60–90	0.20–0.63	0.06–0.08	5.1–6.5	Low.
30–65	25–60	20–55	15–50	0.20–0.63	0.06–0.08	5.6–6.5	Low.
30–65	25–60	20–55	15–50	<0.06	0.04–0.06	5.6–7.3	Low.
100	100	95–100	90–100	<0.06	0.17–0.19	5.6–7.3	High.
100	100	95–100	90–100	<0.06	0.17–0.19	6.1–7.8	High.
100	100	90–100	85–100	0.20–0.63	0.17–0.19	5.6–6.5	Moderate.
100	100	95–100	85–100	0.20–0.63	0.17–0.19	5.6–7.3	Moderate to high.
100	100	95–100	85–100	0.20–0.63	0.17–0.19	6.1–7.8	Moderate to high.
100	100	95–100	85–95	0.20–0.63	0.17–0.19	5.6–7.3	Moderate.
100	100	95–100	90–95	0.06–0.20	0.17–0.19	5.6–7.3	Moderate to high.
100	100	95–100	90–95	0.06–0.20	0.17–0.19	6.6–8.4	Moderate to high.

TABLE 6.—*Estimated soil properties*

Soil series and map symbols	Depth to bedrock	Depth from surface	Classification		
			USDA texture	Unified	AASHO
	Feet	*Inches*			
Sogn. Mapped only in complexes with Clime and Labette soils.	0.4–1.5	0–6 6	Silty clay loam Limestone.	CL	A–6
Solomon: So	>5	0–18 18–60	Silty clay Silty clay	CH CH	A–7 A–7
Stony steep land: St. Properties too variable to be estimated.					
Tully:					
Tc, Ts	>5	0–19 19–60	Silty clay loam Silty clay	CL CH	A–6 A–7
Tu. Properties too variable to be estimated.					
*Zaar: Za, Zd. For properties of Dwight part of Zd, see Dwight series.	>4	0–15 15–54 54–60	Silty clay Silty clay Clay shale and silty clay.	CH CH	A–7 A–7

[1] Coarse fragments larger than 3 inches in diameter make up 10 to 20 percent of this horizon.

TABLE 7.—*Interpretations of*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear

Soil series and map symbols	Suitability as a source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees	Farm ponds: Reservoir areas
Alluvial land and Reading soils: Ar. Properties too variable for reliable evaluation.							
Chase: Ch	Surface layer good.	Unsuitable	Poor: plastic material; low shear strength; moderate stability.	Poor: moderate to high shrink-swell potential.	Moderate stability; moderate to high shrink-swell potential; plastic; moderately well drained to somewhat poorly drained.	Moderate stability and compaction.	Slow permeability; nearly level.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)				
				Inches per hour	*Inches per inch of soil*	*pH*	
100	100	95–100	85–95	0. 63–2. 00	0. 17–0. 19	6. 1–8. 4	Moderate.
100	100	95–100	90–95	< 0. 06	0. 17–0. 19	7. 4–8. 4	High.
100	100	95–100	90–95	< 0. 06	0. 17–0. 19	7. 9–9. 0	High.
100	100	95–100	85–95	0. 20–0. 63	0. 17–0. 19	5. 6–7. 3	Moderate.
100	100	95–100	90–95	0. 06–0. 20	0. 17–0. 19	6. 1–8. 4	High.
100	100	95–100	90–95	< 0. 06	0. 17–0. 19	5. 6–6. 5	High.
100	100	95–100	90–95	< 0. 06	0. 17–0. 19	6. 6–8. 4	High.

[2] Coarse fragments larger than 3 inches in diameter make up 40 to 50 percent of this horizon.

engineering properties

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for in the first column of this table]

Soil features affecting—Continued						Degree of limitations for—	
Farm ponds—Con. Embankments	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Moderate stability and compaction; moderate to high shrink-swell potential.	Subject to minor flooding; moderately well drained to somewhat poorly drained.	Deep; nearly level; slow permeability.	Not applicable.	Not applicable.	Moderate to high shrink-swell potential; subject to minor flooding.	Severe: slow permeability; subject to minor flooding.	Moderate: moderate to high shrink-swell potential subject to minor flooding.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees	Farm ponds: Reservoir areas
*Clime: Cs. For Sogn part of Cs, see Sogn series.	Fair	Unsuitable	Fair: plastic material; low shear strength; fair stability.	Good	Bedrock at depth of 2 to to 3½ feet; possible seep areas: irregular topography.	Fair: stability and and compaction.	Moderately slow permeability; moderately deep to shale.
Dwight: Dw	Poor	Unsuitable	Poor: highly plastic; low shear strength; high shrink-swell potential; low stability.	Poor: high shrink-swell potential; poor compaction.	Highly plastic; very slow permeability; some dispersion.	Cracks when dry; som e dispersion; low stability.	Very slow permeability.
*Florence: Fa, Fm. For Labette part of Fa, see Labette series. For Matfield part of Fm, see Matfield series.	Poor	Fair for dirty road gravel.	Good to poor: depends on size of chert fragments.	Good	Irregular topography; 50 to 85 percent is angular chert fragments.	Borrow material limited and cherty.	Possible seepage.
Irwin: Ic, In, Ir, Is	Surface layer fair; subsoil poor.	Unsuitable	Poor: low shear strength; high shrink-swell potential; high plasticity.	Fair: high shrink-swell potential; low shear strength; low stability.	High plasticity; very slow permeability.	Low stability; highly plastic.	Very slow permeability.
Ivan: Iv	Good	Unsuitable	Fair: moderate stability; subject to flooding.	Good	Nearly level; subject to flooding.	Moderate stability and compaction.	Moderate permeability.
Kahola: Ka	Good	Unsuitable	Fair: moderate stability.	Good	Nearly level; occasionally flooded.	Moderate stability and compaction.	Moderate permeability.

engineering properties—Continued

Soil features affecting—Continued						Degree of limitations for—	
Farm ponds—Con. Embankments	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Moderate to high shrink-swell potential; fair stability and compaction; limited borrow material.	Not applicable.	Not applicable.	Bedrock at depth of 2 to 3½ feet.	Erodible; fine grained; subject to siltation.	No adverse features where soil is over shale.	Severe: moderately deep to bedrock; possible seep areas.	Severe: moderately deep to bedrock; 3 to 18 percent slopes.
Cracks when dry; some dispersion; low shear strength; low stability.	Not applicable.	Not applicable.	Thin surface layer.	Thin surface layer; vegetation difficult to establish.	High shrink-swell potential; low shear strength.	Severe: very slow permeability.	Moderate; plastic material; cracks when dry; low stability.
Borrow material limited; possible seepage; good stability.	Not applicable.	Not applicable.	Not applicable.	Not applicable.	No adverse features.	Severe: moderately slow permeability; bedrock at depth of 3½ to 5 feet.	Severe: bedrock at depth of 3½ to 5 feet; cherty.
Cracks when dry; highly plastic; low stability and compaction.	Not applicable.	Not applicable.	Cracks when dry; very slow permeability.	Subject to siltation; hard to establish vegetation; crusty surface.	High shrink-swell potential; plastic; low shear strength.	Severe: very slow permeability.	Moderate: slope is 1 to 5 percent.
No undesirable features.	Well drained to moderately well drained.	Moderate permeability; high available water capacity; subject to flooding.	Not applicable.	Not applicable.	Subject to flooding.	Severe: subject to flooding.	Moderate if protected from flooding; severe if not protected.
No undesirable features.	Well drained; occasionally flooded.	Moderate permeability; high available water capacity.	Not applicable.	Not applicable.	Subject to occasional flooding.	Moderate: subject to occasional flooding; moderate permeability.	Moderate; moderate stability and compaction; moderate permeability.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting—		
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees	Farm ponds: Reservoir areas
*Labette: La, Lb, Lc, Ld, Le. For Dwight part of Ld, see Dwight series. For Sogn part of Le, see Sogn series.	Good	Unsuitable	Poor: moderate to high shrink-swell potential; low shear strength.	Fair: moderate to high shrink-swell potential; low stability.	Well drained; moderate to high shrink-swell potential; 2 to 3½ feet to limestone.	Low stability; cracks when dry.	Moderately deep to limestone; slow permeability; possible seepage.
Ladysmith: Lm, Lo, Ls	Surface layer fair; subsoil poor.	Unsuitable	Poor: high shrink-swell potential; low shear strength; highly plastic.	Fair: high shrink-swell potential; low shear strength; low stability.	High plasticity; very slow permeability.	Low stability; highly plastic.	Very slow permeability.
Martin: Ma, Mc	Fair	Unsuitable	Poor: moderate to high shrink-swell potential; high plasticity; low shear strength.	Fair: moderate to high shrink-swell potential; low stability; high plasticity.	High shrink-swell potential; low stability; high plasticity; slow permeability	Cracks when dry; low stability.	Slow permeability.
Martin-Gullied land complex: Mg. Properties too variable for reliable evaluation.							
Matfield. Mapped only in a complex with Florence soils.	Poor	Fair for dirty road gravel.	Good to poor: depends on size of chert fragments.	Good: stable fill material.	Irregular topography; 50 to 85 percent is irregular chert fragments.	Borrow material limited.	Possible seepage.
*Olpe: Om. For Smolan part of Om, see Smolan series.	Poor	Fair for dirty road gravel.	Good	Good	Gravelly soils; high stability; irregular topography.	Borrow material limited and gravelly.	Slow to very slow permeability.
Osage: Os	Poor	Unsuitable	Poor: low shear strength; highly plastic.	Fair: low stability.	Subject to flooding; highly plastic; poorly drained; very slow permeability.	Low stability; cracks when dry.	Very slow permeability; sites limited to pits.
Reading: Ra, Rd, Re	Good	Unsuitable	Fair: moderate to high shrink-swell potential.	Fair to good: moderate to high shrink-swell potential.	Moderate to high shrink-swell potential; moderately slow permeability.	Moderate stability and compaction.	Moderately slow permeability.

engineering properties—Continued

Soil features affecting—Continued						Degree of limitations for—	
Farm ponds—Con.: Embankments	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Moderate to high shrink-swell potential; low stability.	Not applicable	Not applicable.	Moderately deep to limestone.	Moderately deep to limestone.	Good where soil is over limestone; moderate to high shrink-swell potential.	Severe: moderately deep to limestone; slow permeability.	Severe: moderately deep to limestone.
Low stability and compaction; highly plastic; cracks when dry.	Moderately well drained to somewhat poorly drained; very slow permeability.	Slow intake rate; very slow permeability.	Cracks when dry; very slow permeability.	Subject to siltation; hard to establish vegetation; crusty surface.	High shrink-swell potential; low shear strength; highly plastic.	Severe: very slow permeability.	Slight.
Low stability and compaction; moderate to high shrink-swell potential; cracks when dry.	Not applicable	Slow permeability.	Clayey subsoil.	Moderately erodible; vegetation hard to establish; subject to siltation.	Poor: high shrink-swell potential; low shear strength.	Severe: slow permeability.	Moderate where slope is 2 to 10 percent.
Borrow material limited; possible seepage; stable fill material.	Not applicable	Not applicable.	Not applicable.	Not applicable.	No adverse features.	Severe: very slow permeability.	Severe: more than 50 percent is coarse fragments.
High stability if mixed.	Not applicable	Not applicable.	Not applicable.	Not applicable.	Good: gravelly subsoil.	Severe: slow to very slow permeability.	Severe: more than 50 percent is coarse fragments.
Severe cracking when dry; low shear strength and stability.	Poorly drained; subject to flooding.	Very slow intake rate; subject to flooding; poorly drained.	Not applicable.	Subject to siltation; nearly level.	High shrink-swell potential; flooding hazard.	Severe: flooding hazard; very slow permeability.	Severe: high shrink-swell potential; unstable and subject to flooding.
No adverse features.	Nearly level; moderately slow permeability.	Deep; moderately slow permeability.	No adverse features.	No adverse features.	Moderate to high shrink-swell potential.	Severe: moderately slow permeability.	Slight; moderate where slope is more than 2 percent.

TABLE 7.—*Interpretations of*

Soil series and map symbols	Suitability as a source of—				Soil features affecting-		
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees	Farm ponds: Reservoir areas
Smolan: Sm	Good	Unsuitable	Fair: moderate to high shrink-swell potential; fair stability.	Fair to poor: low shear strength; plastic.	Well drained to moderately well drained; moderate to high shrink-swell potential.	Fair stability; cracks when dry.	Slow permeability.
Sogn. Mapped only in complexes with Clime and Labette soils.	Poor	Unsuitable	Poor: moderate shrink-swell potential.	Good, but limited amount.	Limestone at depth of ½ to 1½ feet; moderate plasticity.	Limestone at depth of ½ to 1½ feet.	Shallow to limestone.
Solomon: So	Poor	Unsuitable	Poor: highly plastic; high shrink-swell potential.	Fair: low stability.	Highly plastic; poor internal drainage; low stability; very slow permeability.	Low stability; cracks when dry.	Sites limited to pits; very slow permeability.
Stony steep land: St. Properties too variable for reliable evaluation.							
Tully:							
Tc, Ts	Fair	Unsuitable	Poor: low shear strength; high shrink-swell potential; high plasticity.	Fair: high shrink-swell potential; low stability; high plasticity.	High plasticity; low stability; slow permeability.	Cracks when dry; low stability.	Slow permeability.
Tu. Properties too variable for reliable evaluation.							
*Zaar: Za, Zd. For Dwight part of Zd, see Dwight series.	Poor	Unsuitable	Poor: plastic material; low shear strength; high shrink-swell potential.	Poor: high shrink-swell potential; plastic; low stability.	Low stability; plastic material; very slow permeability.	Low stability; cracks when dry.	Very slow permeability.

engineering pro perties—Continued

Soil features affecting—Continued						Degree of limitations for—	
Farm ponds—Con. Embankments	Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Moderate to high shrink-swell potential; fair stability.	Not applicable	Not applicable.	No adverse features.	Subject to siltation.	Moderate to high shrink-swell potential.	Severe: slow permeability.	Moderate where slope is 2 to 10 percent.
Limited amount of borrow material; moderate stability.	Not applicable	Not applicable.	Not applicable.	Not applicable.	Limestone at depth of ½ to 1½ feet.	Severe: shallow to limestone.	Severe: shallow to limestone.
Severe cracking when dry; low shear strength and stability.	Very slow permeability; poorly drained; subject to flooding.	Very slow intake rate; poorly drained.	Not applicable.	Nearly level; subject to siltation.	High shrink-swell potential; subject to flooding.	Severe: very slow permeability; hazard of flooding.	Severe: high shrink-swell potential; unstable soil; subject to flooding.
Low stability and compaction; high shrink-swell potential; cracks when dry.	Not applicable	Slow permeability; high available water capacity.	Clayey subsoil.	Subject to siltation; clayey subsoil.	High shrink-swell potential.	Severe: slow permeability.	Moderate where slope is 3 to 7 percent.
High shrink-swell potential; low stability and compaction; cracks when dry.	Not applicable	Not applicable.	Clayey soil; very slow permeability; cracks when dry.	Difficult to establish seedbed.	Low shear strength; high shrink-swell potential.	Severe: very slow permeability.	Moderate where slope is 2 to 7 percent.

Formation and Classification of the Soils

The first part of this section deals with the formation of soils in this county. It tells how the main soil-forming processes have interacted to produce the various kinds of soil. The second part deals with the classification of soils.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or altered by geologic forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of soil profile that is formed and in a few places may determine it almost entirely. Finally, time is needed for changing the parent material into a soil. It may be much or little, but some time is always required for soil horizon differentiation. Usually, a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

Parent material is the unconsolidated mass from which soil is formed. Parent material is formed by the weathering of rocks through the processes of freezing and thawing, abrasion, erosion, deposition by wind and water, and by chemical processes.

The soils of Chase County developed from material derived from the Lower Permian limestone and shale, gravelly outwash, eolian silts and clays, and alluvium.

Lower Permian limestone and shale.—This is the bedrock from which the residual soil materials in Chase County are weathered. It consists of all members from the thick Wellington Shale, which crops out about 1 mile north of Wonsevu, Kansas, to the West Branch Shale, a member of the Admire group of rocks, which occurs in the Verdigris River Valley in southeast Chase County (*6*).

Residuum from bedrock was the parent material for the Clime, Sogn, Florence, Matfield, Labette, Martin, and Zaar soils.

Such soils as Matfield and Florence soils formed in material weathered from cherty limestone, such as that of the Florence and Threemile Formations. The Sogn soils formed over a number of kinds of limestone throughout the county. Material weathered from limestone or calcareous shale closely associated with limestone is the parent material of the Labette soils. The silty clay Clime and Zaar soils formed in material weathered from clayey shale. In most places these soils are associated with the Eskridge Shale Formation.

Some soils apparently have parent material derived from more than one source.For instance, the lower part of the Dwight and Irwin soils formed in material weathered from shale, but in many places the upper part appears to have been formed in transported material.

Tully soils formed on foot slopes in slope-wash materials that mostly were derived from residuum.

Gravelly outwash.—East of the Flint Hills in Chase County, belts of terraces border the major streams at elevations of 50 to 150 feet or more above the flood plains. The thickness of these alluvial accumulations ranges from a few inches to about 16 feet (*6*). Olpe soils developed in gravelly, clayey outwash on old high terraces east of the Flint Hills. This material was derived chiefly from cherty Lower Permian limestone that is exposed in the Flint Hills. In places the Irwin and Tully soils formed partly in outwash from residuum.

Eolian silt and clay.—Eolian deposits in Chase County are less than 5 feet thick in most places. Because the deposits are thin, it is difficult to determine the total influence on the soils of the county. The Ladysmith soils apparently formed in eolian material. In some places the upper part of the Irwin soils apparently formed in eolian material. Smolan soils developed reddish-colored silts and clays that may be old eolian deposits, or they may have been deposited by water.

Alluvium.—Alluvium is the parent material for all soils formed on the flood plains and stream terraces of all the major streams in the county. This soil material ranges from the silts on the first bottoms of the Cottonwood and South Fork Cottonwood Rivers to the dense clay in the back-water sediment areas on the stream terraces of the Cottonwood River.

The texture, position, and age of the alluvium influence the soil profile. Ivan soils formed in silty calcareous material on low bottoms that are frequently flooded. These soils are calcareous and stratified because of frequent additions from floodwaters. Kahola soils occur at slightly higher levels. They are of similar texture, but lack the stratification, and the A horizon is noncalcareous. Reading and Chase soils are on terraces that are seldom flooded. They are more clayey and have more profile development. The higher clay content probably is partly a result of the texture of the alluvium and partly a result of the age of the material. Osage and Solomon soils are clayey. They occur in slack-water areas, where fine-textured material settled out of the water.

Climate

The climate of Chase County is subhumid. The average precipitation is about 32 inches. The summers are warm, and the winters are cool.

Climate influences both the physical and chemical weathering processes at work on the parent material. The percolation of water is a major factor in transforming the parent material into a soil that has distinct hori-

zons. The amount of water that will percolate through the soil depends on the amount, type, and intensity of precipitation, humidity, relief, temperature, and the nature of the soil material. In some soils, percolation through the subsoil is slow. As a result, a weak zone of carbonate accumulation is formed. This is true of the Ladysmith soils. In other soils, the processes of percolation are impeded by erosion, slope, and slow water intake rate so that little leaching of bases has occurred. This is true of the Clime soils, which are calcareous to the surface.

Soil-forming factors are most active when the soil is warm and moist. Lack of rainfall for periods aids in soil development. Many of the clay soils crack, which increases the movement of water through the soil when it rains. Climate indirectly affects many alluvial soils, because in periods of heavy rainfall the streams flood, depositing silt on some soils of the valley lands.

The structure of the soil is modified by freezing and thawing. Freezing and thawing of clay soils tend to form the surface layer into aggregates. This is particularly noticeable on Osage, Solomon, and Zaar soils. In cultivated fields, after freezing and thawing in winter, the surface layer often forms hard, discrete granules. After tillage and wet periods, much of the aggregation is destroyed. The alternate wetting and drying and freezing and thawing is an important part in the process of soil formation in this county.

Climate is a very imortant factor in causing wide differences in soils over a wide region, but differences because of climate are slight in an area the size of Chase County.

Plant and animal life

Of all the living organisms that influence the formation of soil, the effect of vegetation is the most easily recognized. Prairie grases provided the organic matter that has accumulated in the soils of Chase County. This organic material has darkened the uppermost layers of the soil.

The important functions of plant and animal life in the soil-forming processes are the furnishing of organic matter and the bringing up of nutrients from the lower layers to the surface layer. The important sources of organic matter are the trunks, stems, leaves, and roots of plants. This organic material modifies the color, structure, and other chemical and physical properties of the soil, thus creating a favorable environment for biological activity. More organic material is added where the water relationship is favorable and grasses grow high. For example, the nearly level areas of Ladysmith soils are commonly darkened to greater depths than the gently sloping areas. The nearly level areas for years had a more favorable moisture regime, more organic matter was added, and little soil was lost by erosion.

Burrowing animals aid in mixing various soil horizons, and to some extent, bring fresh material into the surface layer. Earthworms feed on organic matter in the soil and thoroughly mix the soil in which they live. Earthworm activity is particularly noticeable in soils where the organic-matter content is higher. Osage, Reading, Ivan, and Chase soils all show distinct signs of earthworm activity. This is an important part of the soil development. All soils are in some degree affected by earthworms, even cherty soils such as Florence and Matfield soils.

The soils in Chase County formed under tall grass prairie, which supplies quantities of organic matter that makes the surface layer dark colored and gives it a strong structure. Some soils, such as those of the Dwight and Sogn series, support mid and short grasses. Soils formed under the shorter grasses are commonly darkened less deeply. This is a reflection of less organic material being added from grass residue.

In most places that are not cultivated, Ivan soils have trees on them, but the soil is so young that trees have not contributed significantly to soil development.

Relief

Relief tends to modify the influences of the active factors of soil formation. The influence of relief upon soil formation is due to its controlling effect on drainage, runoff, and other water effects, including normal and accelerated erosion. The amount of water that moves through the soil depends partly on topography. As a rule, on steep slopes less water enters the soil and more soil material is removed by erosion than on gentle slopes. Low and flat topography generally means that the soil receives extra water in the form of runoff from higher lying soils. This additional water is reflected in gray or mottled colors or in higher amounts of organic matter in the surface layer. Nearly level soils on uplands generally have a more strongly developed profile than steep soils. This is due to a slower rate of runoff in the level areas, which allows more water to percolate through the soil and lessens the removal of soil from the surface.

The modifying effects of relief are evident where two soils have the same parent material but occur on different relief. Florence and Matfield soils, which occur adjacently, formed in material weathered from cherty limestone. The differences in profile characteristics are due to relief. Matfield soils occupy the crests of ridges where the slope is 1 to 5 percent, and Florence soils occur on side slopes of 3 to 15 percent. The Matfield soils are more deeply weathered than Florence soils and have a thicker A horizon. The lower part of the A horizon in Matfield soils is lighter colored; the A horizon of Florence soils is dark colored throughout. The gently sloping areas where Matfield soils formed were stable enough to allow the development of a deep, highly weathered profile. In the more sloping areas, where Florence soils occur, erosion and runoff have resulted in less soil development.

Some soils developed on slopes where the processes of erosion have been active. Soils formed on these kinds of slopes are in their infancy in terms of soil development. The Clime soils occur where the slope is 3 to 25 percent. On these steep slopes, where soft shale is the parent material, the erosion process has been active. As a result of relief and the nature of the parent material, the Clime soils are calcareous in all horizons. In other areas where the parent material is similar shale, and where the relief and slope are less, a leached soil, such as a Martin or Zaar soil, has formed.

Time

Time is needed for soil formation. The amount of time needed to develop a mature soil will vary with the other

factors of soil formation. The elapsed time needed to develop a mature soil where the soil material is medium textured is much less than where the soil material is fine textured. The time needed to develop a soil where the material is loess or alluvium is much less than the time needed to develop a soil on a resistant shale.

Water moves through the soil profile, and over a period of time, soluble substances and fine particles are leached from the surface layer and deposited in the subsoil. The amount of leaching depends on the elapsed time and the amount of water that penetrates the soil. For example, the Ivan soils in very recent alluvium show very little horizon development other than darkening of the surface layer; the cherty Matfield soils, which have been exposed to soil-forming processes for thousands of years, have well-defined horizons.

The time a soil has had to develop in Chase County varies widely. Some soils, such as Ivan soils, are very young and weakly developed; soils such as Matfield and Florence soils are among the oldest soils in the State.

Classification of the Soils

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*9*). The system currently used was adopted by the National Cooperative Soil Survey in 1965. It is under continual study. Therefore, readers interested in developments of the current system should search the latest literature available (*8*, *12*). Table 8 shows the classification of each soil series of Chase County by family, subgroup, and order, according to the current system.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available. The classes of the current system of classification are briefly discussed in the following paragraphs.

ORDER.—Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different kinds of climate. Mollisols is the only order represented in Chase County.

Mollisols formed under grass and have a thick, dark-colored surface horizon that contains colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

SUBORDER.—Each order has been subdivided into suborders, primarily on the basis of characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation. The suborder is not shown separately in table 8, because it is part of the last word in the name of the subgroup.

TABLE 8.—*Classification of soil series*

Series	Family	Subgroup	Order
Chase	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Clime	Fine, mixed, mesic	Udic Haplustolls	Mollisols.
Dwight [1]	Fine, montmorillonitic, mesic	Typic Natrustolls	Mollisols.
Florence [2]	Clayey-skeletal, montmorillonitic, mesic	Udic Argiustolls	Mollisols.
Irwin	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Ivan	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kahola	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Labette	Fine, mixed, mesic	Udic Argiustolls	Mollisols.
Ladysmith	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Martin [3]	Fine, mixed, mesic	Aquic Arqiudolls	Mollisols.
Matfield	Clayey-skeletal, montmorillonitic, mesic	Abruptic Pachic Paleustolls	Mollisols.
Olpe	Clayey-skeletal, montmorillonitic, thermic	Typic Argiudolls	Mollisols.
Osage	Fine, montmorillonitic, noncalcareous, thermic	Vertic Haplaquolls	Mollisols.
Reading	Fine, mixed, mesic	Typic Argiudolls	Mollisols.
Smolan [4]	Fine, montmorillonitic, mesic	Pachic Argiustolls	Mollisols.
Sogn	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Solomon	Fine, montmorillonitic, calcareous, mesic	Vertic Haplaquolls	Mollisols.
Tully	Fine, mixed, mesic	Pachic Argiustolls	Mollisols.
Zaar	Fine, montmorillonitic, thermic	Vertic Hapludolls	Mollisols.

[1] Data from mechanical and chemical analyses of the Dwight series, as sampled in Butler County (*13*).

[2] The lower limit of the range in reaction for all horizons is lower than the range described for the series, but this difference does not alter the usefulness or behavior of these soils. Data from mechanical and chemical analyses of the Forence and Matfield soils sampled in Chase County, and of the Irwin soils sampled in Butler County, can be obtained from the Soil Conservation Service, Soil Survey Laboratory, Lincoln, Nebraska.

[3] The reaction of all horizons except the A1 and AB horizons is more alkaline in these soils than the range described for the series, but this difference does not alter their usefulness or behavior.

[4] The B2t horizon is thicker and the lower part of the B2t horizon is more mottled in these soils than in those described for the series, but this difference does not alter their usefulness or behavior.

GREAT GROUP.—Suborders are separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8, because it is the last word in the name of the subgroup.

SUBGROUP.—Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the great group.

FAMILY.—Families are separated within a subgroup primarily on the basis of properties important in the growth of plants or behavior of soils when used in engineering work. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.—The series is a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

Additional Facts About the County

This section gives information about the history and population of Chase County and facts about farming. It also discusses the physiography, relief, and drainage; the climate; the water supply; the industry and resources; and the markets and transportation.

History and Population

Chase County was explored in 1806 by members of the Zebulon Pike Expedition. This group traveled up the Verdigris Valley to Camp Creek and across the hills to the Cottonwood River; then they proceeded on to the north and west.

The first settlers built cabins on the South Fork of the Cottonwood River in 1855. By 1857 several families had settled around Bazaar, Kansas. In 1859, the county was organized with 529 inhabitants. The first flour mill and the first newspaper, "The Kansas Press," were begun in 1859. Cottonwood Falls was incorporated in 1872.

Since the settlement of the county in the 1850's, the county has had an early increase in population and later a decrease in population. For example, the population was 1,046 in 1860; it was 6,259 in 1920 but had decreased to 3,978 in 1960.

The decrease in population in recent years parallels the reduction in the number of farms and in the number of acres under cultivation.

Farming

The first plowing was done in the valley of the South Fork of the Cottonwood River in the mid 1850's. The cutting of wild or prairie hay probably was the first effort at farming in the county. Much of the first hay cut went to Council Grove for use by the Indian Agency. The early settlers built their cabins on the creek and river bottoms, and the first farming was done on those bottoms. By 1880, upland areas in the northeastern and southwestern parts of the county were plowed out from the native sod. The early settlers broke out many areas that were later returned to rangeland. The reduction in cultivated acreage continued from the early days to 1964, when 61,132 acres were harvested for crops. In 1934, by contrast, 79,307 acres were harvested for crops.

Chase County has always been a center of the beef cattle industry. The growing of crops is mainly for winter feed for livestock, but some areas are used for cash crops.

The first barbed wire fences were built in the period 1875 to 1877. Fencing of the large native pastures did not begin until 1900. Until the railroad reached Bazaar in 1887, most of the cattle grazed in the county were local cattle. From 1887 on, large numbers of aged steers from Texas, New Mexico, and the southwest were shipped in for summer grazing. This shipment of aged steers each spring for summer grazing continued until the early 1950's, when it began to taper off in favor of yearlings and young cattle. One of the significant recent livestock developments has been the building of large commercial feedlots in the county. These feedlots make a good market for locally produced grain and silage crops.

In 1964 crops were harvested from 61,132 acres. The principal crops and the acreage harvested were:

Crops	*Acres*
Wheat	18,000
Sorghum for grain	8,900
Sorghum for silage	5,700
Alfalfa	11,700
Corn for silage	7,400
Corn for grain	100
Soybeans	2,000

There were minor amounts of oats, barley, and rye (*5*).

The shift in production over the years indicates less corn and oats for grain and more sorghum and corn for silage. There has also been an increase in the acreage of soybeans and alfalfa.

The raising of cattle has always been the primary source of income for the county. Receipts from livestock and livestock products greatly exceed the income from other sources. Although there have always been a few cowherds in the county, the summer grazing program has been the predominant system used on native range. At the present time, there is a gradual shift to cowherds. The number of cattle on farms has shown a steady increase since 1935.

About 80 percent of Chase County is used for native range. This native range has been used to 90 percent of its capacity since 1900. More than 100,000 cattle are summer grazed in the county every year. The increase in numbers of cattle on a year-round basis is due not only to more cow-calf herds, but also to an increase in capacity of feedlots. There are several large feedlots in the county

that are operated on a year-round basis. An indication of the trend of the cattle industry is shown by the number of cattle marketed for the past few years. For example, the number of cattle sold in 1939 was 23,852. By 1964, the number had increased to 115,169. In 1964, 97,599 head of cattle were grain-fed and marketed from Chase County.

There are small numbers of milk cows, hogs, and sheep. There is one large commercial egg farm in the county. It has a capacity of 25,000 layers.

Physiography, Relief, and Drainage

Chase County is in the Osage Cuesta Plain section of the Central Lowlands and the Flint Hills Uplands (*6*).

The main topographic features are the east-trending Cottonwood and Verdigris River Valleys and the uplands, which consist of rounded to steep hills.

The Cottonwood River and its tributaries drain all except about two townships of land in the southeastern part of the county. This area is drained by the Verdigris River. The uplands make up about 86 percent of the county, and the bottom lands, about 14 percent.

The elevation of the county is 1,100 to 1,500 feet above sea level. The highest point is in the southwestern part of the county, and the lowest point is in the southeastern part of the county where the Verdigris River leaves the county.

Climate

Except for deficient rainfall in some growing seasons, climatic conditions in Chase County are generally favorable for successful production of crops. The percent of possible sunshine, the growing season temperatures, and the seasonal distribution of precipitation all contribute to a high production potential for the area.

Midwestern United States, including Chase County, has a continental climate characterized by wide daily and annual temperature ranges, light wintertime precipitation, and a pronounced rainfall peak in the warmer season, as shown in table 9. A changeable weather pattern is the rule in that area, especially in fall, winter, and spring. Low pressure storms, which frequent the Midwest during these seasons, contribute to the marked day-to-day weather variations.

The principal source of moisture for precipitation in Kansas is the Gulf of Mexico (*4*). The eastern half of Kansas is frequently in a warm, moist airflow from the Gulf, and the collision of this air with cooler air from northern latitudes accounts for a large percentage of the annual precipitation in Chase County.

Precipitation is heaviest late in spring and early in summer, and rainfall in both May and June averages more than 4 inches. About 71 percent of the average annual precipitation falls during the growing season, April through September. Only 9 percent falls during the period December through February. This distribution favors the growth of warm-season crops and grasses.

Much of the moisture falls as nighttime or early morning thundershowers during the warmer part of the year. These storms are violent at times and produce heavy rain, large hailstones, strong winds, and tornadoes. The severe storms that occur are usually local in extent, of short duration, and produce damage in a variable and spotty pattern. Heavy thunderstorms cause flooding in the lower lying areas and erosion on sloping soils that are cultivated. Benefits to crops from thunderstorm rainfall, however, far outweigh the damages.

Precipitation is variable from month to month and from year to year. Rainfall records for the Cottonwood Falls area date back to 1902, and from that date to 1966, the annual rainfall has ranged from 19.47 inches in 1953 to 57.11 inches in 1951. Dry weather of several months duration is not uncommon in Chase County, and droughts extending over a period of years may occur at irregular intervals. The drought from 1952 to 1957 was especially severe in Chase County and elsewhere in eastern Kansas.

Because of the continental climate, the annual temperature range in Chase County is rather wide. Relatively intense solar heating during the warm season and occasional surges of arctic air in winter and early in spring contribute to these temperature variations. Winters are characterized by cold, dry weather, and summers are generally warm to hot. Temperature extremes for the period of record at Cottonwood Falls have ranged from −30° F. to 118°.

The transition from the cold to the warm season, and vice versa, occurs rather rapidly. March has a mean temperature of 44.3° compared to 55.8° in April. The change in temperature is even greater between October (59.0°) and November (44.8°).

The probabilities for the last freeze in spring and the first in fall at Cottonwood Falls are given for five thresholds in table 10. The freeze-free period in Chase County averages nearly 185 days and extends from about April 20 to October 20 (*3*). This relatively long growing season contributes to a minimum of crop loss from freezing weather.

Snowfall is light in Chase County; it averages about 17 inches per year. Wintertime snowfall has been as much as 36 inches at Cottonwood Falls, but it is unusual for more than 30 inches to fall during a winter season. Snow that accumulates on the ground usually melts within a week.

The prevailing winds in Chase County are southerly. Surface winds are generally light to moderate in all seasons. There are more windy days in spring, however, than in other seasons of the year.

Water Supply

The water supply in most of Chase County is variable. In the southwestern part of the county, water for domestic use and for livestock is obtained mostly from dug wells. The water supply is generally dependable, and the water is of good quality. There is only one other upland area in the county where good wells consistently can be found. This area is on the gravelly terraces paralleling the main streams.

In other areas of the county, adequate dug wells on the uplands are difficult to obtain. Most successful wells in these areas are dug in the shallow alluvial deposits along small drainageways.

[9] By MERLE J. BROWN, climatologist for Kansas, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation at Cottonwood Falls*

Month	Temperature				Precipitation		
	Average daily maximum [1]	Average daily minimum [1]	Two years in 10 will have about 4 days with— Maximum temperature equal to or higher than [2]—	Two years in 10 will have about 4 days with— Minimum temperature equal to or lower than [2]—	Average total [3]	One year in 10 will have— Less than [4]—	One year in 10 will have— More than [4]—
	° F.	° F.	° F.	° F.	Inches	Inches	Inches
January	42.0	19.4	62	−2	0.83	0.11	1.68
February	47.6	23.3	66	5	1.11	.21	2.23
March	57.3	31.2	78	14	1.85	.76	3.72
April	68.4	43.3	85	30	2.92	1.25	5.22
May	76.5	52.9	90	40	4.33	2.14	7.37
June	86.4	62.7	99	52	4.35	1.14	8.22
July	92.5	66.9	104	58	3.84	1.06	8.34
August	91.9	66.1	103	56	3.78	1.08	7.52
September	83.9	57.5	98	41	3.73	.74	6.26
October	72.2	45.8	89	31	2.62	.66	5.50
November	57.1	32.4	74	17	1.75	.03	3.58
December	44.7	22.9	63	7	1.05	.10	2.42
Year	68.4	43.7	[5] 105	[6] −9	32.16	22.84	40.03

[1] Period of record, 1905 to 1960.
[2] Period of record, 1940 to 1960.
[3] Period of record, 1902 to 1960.
[4] Period of record, 1905 to 1965.
[5] Average annual maximum; period of record, 1905 to 1965.
[6] Average annual minimum; period of record, 1905 to 1965.

TABLE 10.—*Probabilities of last freezing weather in spring and first in fall for central Chase County*

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	March 28	April 6	April 10	April 23	May 5
2 years in 10 later than	March 22	March 31	April 5	April 18	April 30
5 years in 10 later than	March 10	March 21	March 27	April 8	April 20
Fall:					
1 year in 10 earlier than	November 11	October 30	October 22	October 15	October 5
2 years in 10 earlier than	November 17	November 4	October 26	October 20	October 9
5 years in 10 earlier than	November 29	November 15	November 5	October 29	October 19

Water for livestock is supplied for the most part by farm ponds on intermittent streams. Wells or cisterns are the main source of livestock water around farmsteads and feedlots.

Water supplies are generally adequate in the valleys along the main streams of the county. Wells that yield 75 to 200 gallons per minute can be developed successfully in these areas. Quality of water from wells in alluvial soils is good, but the water is hard.

Dependable sources of water for livestock and for domestic use in some areas of Chase County are natural springs and artesian wells. Several natural springs are in use in the southwestern part of the county. These include Jack Springs, Perkins Spring, and Rock Spring. Some seepy areas could be developed for water supply and would be a good source of water. Except for most of the rough pasture area, Chase County is generally well supplied with wells, permanent streams, and springs. In rough pasture areas the development of deep ponds for water supply is needed.

Irrigation is practiced to a limited extent in dry periods in Chase County. The source of water is permanent streams, such as the South Fork of the Cottonwood River, Cedar Creek, and the Cottonwood River. The supply from streams is limited, and water often is not available when needed. In dry periods, such as in 1955 and 1956, all streams ceased to flow; in normal years, however, water from streams can be used.

Tests indicate that water from tributary streams of the Cottonwood River, such as South Fork and Cedar Creek, is excellent to good. Water from these streams can be safely used for irrigation on many soils in all years.

The use of water from the Cottonwood River for irrigation is questionable. When the water level is high or when the flow is above normal, the quality of the water is good to excellent. In dry periods, the quality is good to poor; it is poor in exceptionally dry periods. If the Cottonwood River is the source of irrigation water, only the permeable soils, such as those of the Ivan, Kahola, and Reading series, can be safely irrigated over a period of years. Water from high flow could be used safely for supplemental irrigation on some of the Chase and Reading soils. The wells developed in alluvial soils are not a dependable source of irrigation water.

Industry and Resources

Ranching and farming are the main enterprises in Chase County.

There has been little industrial development in the county that is not directly related to farming. The important industries in Chase County are feedlots, one egg cracking plant, one small plant that manufactures power mowers, and one plant that manufactures rodeo equipment. Strong City is the site of the annual Flint Hills Rodeo, one of the largest rodeos in the Middle West.

There is one large pumping station on a gasline in the county.

The county has available high-quality limestone that could be used for building purposes. Oil, gas, and limestone are the only nonrenewable natural resources of consequence in the county. A few beds of rounded chert gravel provide surfacing material for roads.

Markets and Transportation

Markets for all farm products are readily available. Most feed grain not used on the farm is sold locally. Most excess crop production in the county is sold to owners of local feedlots. Livestock is trucked to markets in Emporia, Wichita, Kansas City, and St. Joseph, Missouri. Poultry, eggs, and milk are generally sold locally.

Chase County has excellent railroad facilities. The main line of the Santa Fe Railroad traverses the county in an east-west direction. Feeder freight lines run south through Matfield Green, and a branch line is also available up the Diamond Creek Valley through Hymer.

The county is crossed by U.S. Highway 50, and the southeast corner of the county is crossed by the Kansas Turnpike. Kansas Highway 177 traverses the county in a north-south direction. In addition, the county has a good system of all-weather farm-to-market roads, which run along most creek valleys.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Claypan. A compact, slowly permeable soil horizon that contains more clay than the horizon above and below it. A claypan is commonly hard when dry and plastic or stiff when wet.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Forb. Any herbaceous plant, neither a grass nor a sedge, that is grazed on western ranges.

Full feed. A feed or ration that is fed to the limit of the animal's appetite.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Scrub trees. Tree species that readily establish themselves on some range sites when they are overgrazed. These species are American elm, hackberry, osage-orange, willow species, box elder, cottonwood, soft maple, and locust in Chase County.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and the soil series to which the mapping unit belongs. In referring to a capability unit or range site, read the introduction to the section it is in for general information about its management. For use of the soils for woodland and windbreaks, refer to the section beginning on page 38. Other information is given in tables as follows:

Acreage and extent, table 1, page 8.
Predicted yields, table 2, page 32.
Use of the soils for recreation, table 4, page 42.
Engineering uses of the soils, tables 5, 6, and 7, pages 46 through 57.

			Capability unit		Range site		Windbreak suitability group
Map symbol	Mapping unit	Page	Symbol	Page	Name	Page	Symbol
Ar	Alluvial land and Reading soils----------	8	VIw-1	31	Loamy Lowland	36	A
Ch	Chase silty clay loam 1/-----------------	9	IIw-2	26	Loamy Lowland	36	A
Cs	Clime-Sogn complex----------------------	9					
	Clime soil------------------------	--	VIe-2	30	Limy Upland	36	D
	Sogn soil-------------------------	--	VIe-2	30	Shallow Limy	37	G
Dw	Dwight silt loam, 1 to 3 percent slopes--	10	IVe-1	29	Claypan	34	E
Fa	Florence-Labette complex----------------	11					
	Florence soil---------------------	--	VIe-4	30	Loamy Upland	36	F
	Labette soil----------------------	--	VIe-4	30	Loamy Upland	36	C
Fm	Florence-Matfield cherty silt loams------	11					
	Florence soil---------------------	--	VIe-3	30	Loamy Upland	36	F
	Matfield soil---------------------	--	VIe-3	30	Flint Ridge	36	G
Ic	Irwin silty clay loam, 1 to 3 percent slopes---------------------------------	12	IIIe-1	26	Clay Upland	35	C
In	Irwin silty clay loam, 1 to 3 percent slopes, eroded-----------------------	12	IIIe-6	28	Claypan	34	E
Ir	Irwin silty clay loam, 3 to 5 percent slopes---------------------------------	12	IIIe-5	28	Clay Upland	35	C
Is	Irwin silty clay loam, 3 to 5 percent slopes, eroded-----------------------	12	IVe-2	29	Claypan	34	E
Iv	Ivan silt loam 2/-----------------------	13	IIw-1	26	Loamy Lowland	36	A
Ka	Kahola silt loam 1/---------------------	14	I-1	25	Loamy Lowland	36	A
La	Labette silty clay loam, 1 to 3 percent slopes---------------------------------	14	IIe-1	25	Loamy Upland	36	C
Lb	Labette silty clay loam, 3 to 5 percent slopes---------------------------------	14	IIIe-3	27	Loamy Upland	36	C
Lc	Labette silty clay loam, 2 to 5 percent slopes, eroded-----------------------	15	IIIe-7	29	Clay Upland	35	C
Ld	Labette-Dwight complex, 1 to 3 percent slopes---------------------------------	15					
	Labette soil----------------------	--	IIIe-2	26	Loamy Upland	36	C
	Dwight soil-----------------------	--	IIIe-2	26	Claypan	34	E
Le	Labette-Sogn complex--------------------	15					
	Labette soil----------------------	--	VIe-3	30	Loamy Upland	36	C
	Sogn soil-------------------------	--	VIe-3	30	Shallow Limy	37	G
Lm	Ladysmith silty clay loam, 0 to 1 percent slopes---------------------------------	16	IIs-1	26	Clay Upland	35	C
Lo	Ladysmith silty clay loam, 1 to 3 percent slopes-------------------------	16	IIIe-1	26	Clay Upland	35	C
Ls	Ladysmith silty clay loam, 1 to 3 percent slopes, eroded-----------------	16	IIIe-6	28	Claypan	34	E
Ma	Martin silty clay loam, 2 to 6 percent slopes---------------------------------	17	IIIe-4	27	Loamy Upland	36	C
Mc	Martin silty clay loam, 2 to 6 percent slopes, eroded-----------------------	17	IIIe-5	28	Clay Upland	35	C
Mg	Martin-Gullied land complex-------------	17	VIe-1	29	Clay Upland	35	C
Om	Olpe-Smolan complex---------------------	18					
	Olpe soil-------------------------	--	VIe-4	30	Loamy Upland	36	F
	Smolan soil-----------------------	--	VIe-4	30	Loamy Upland	36	C

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Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Range site Name	Range site Page	Windbreak suitability group Symbol
Os	Osage silty clay 3/	19	IIIw-1	29	Clay Lowland	35	B
Ra	Reading silt loam, 0 to 1 percent slopes 1/	20	I-1	25	Loamy Lowland	36	A
Rd	Reading silt loam, 1 to 3 percent slopes 1/	20	IIe-2	25	Loamy Upland	36	A
Re	Reading soils, 6 to 12 percent slopes, eroded 1/	20	IVe-3	29	Loamy Upland	36	A
Sm	Smolan silty clay loam, 2 to 6 percent slopes	21	IIIe-4	27	Loamy Upland	36	C
So	Solomon silty clay 3/	22	IIIw-1	29	Clay Lowland	35	B
St	Stony steep land	22	VIIe-1	31	Breaks	34	F
Tc	Tully silty clay loam, 3 to 7 percent slopes	23	IIIe-4	27	Loamy Upland	36	C
Ts	Tully silty clay loam, 3 to 7 percent slopes, eroded	23	IIIe-5	28	Clay Upland	35	C
Tu	Tully cherty silty clay loam, 5 to 15 percent slopes	23	VIe-4	30	Loamy Upland	36	F
Za	Zaar silty clay, 3 to 7 percent slopes	24	IIIe-5	28	Clay Upland	35	E
Zd	Zaar-Dwight complex, 1 to 3 percent slopes	24					
	Zaar soil	--	IIIe-2	26	Clay Upland	35	E
	Dwight soil	--	IIIe-2	26	Claypan	34	E

1/ Soil in woodland suitability group 3.

2/ Soil in woodland suitability group 1.

3/ Soil in woodland suitability group 2.

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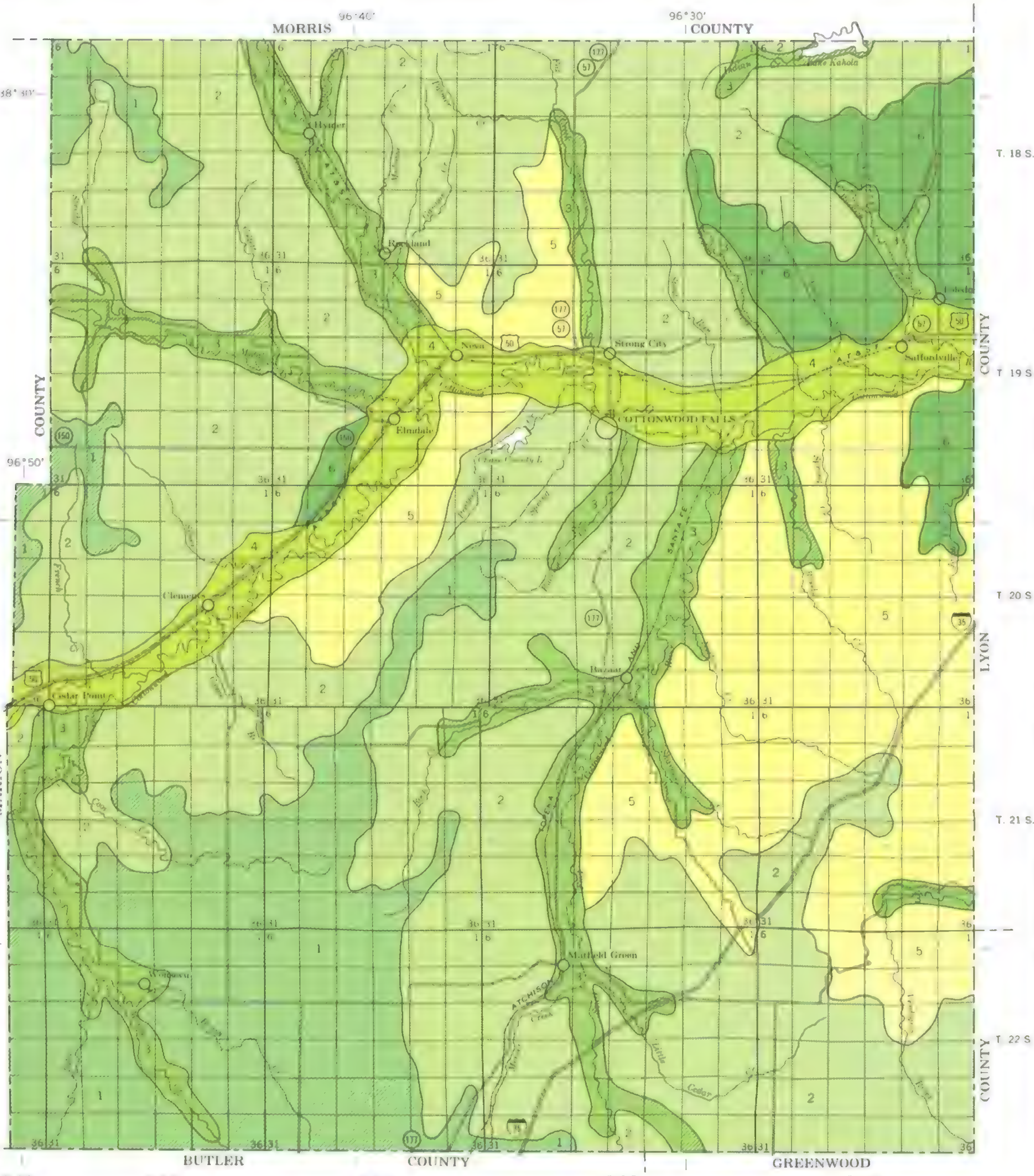

SOIL ASSOCIATIONS

1 — Labette-Irwin association: Gently sloping and sloping, moderately deep and deep soils that have a subsoil of silty clay; on uplands

2 — Florence-Labette association: Gently sloping to strongly sloping, deep and moderately deep soils that have a subsoil of cherty clay or silty clay; on uplands

3 — Reading-Tully association: Nearly level to sloping, deep soils that have a subsoil of silty clay loam or silty clay; on terraces and uplands

4 — Chase-Osage association: Nearly level, deep soils that have a subsoil of silty clay; on flood plains and low terraces

5 — Clime-Sogn association: Gently sloping to steep, moderately deep soils that have a subsoil of silty clay, and shallow silty clay loams; on uplands

6 — Ladysmith-Martin association: Nearly level to sloping, deep soils that have a subsoil of silty clay; on uplands

Compiled 1972

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U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

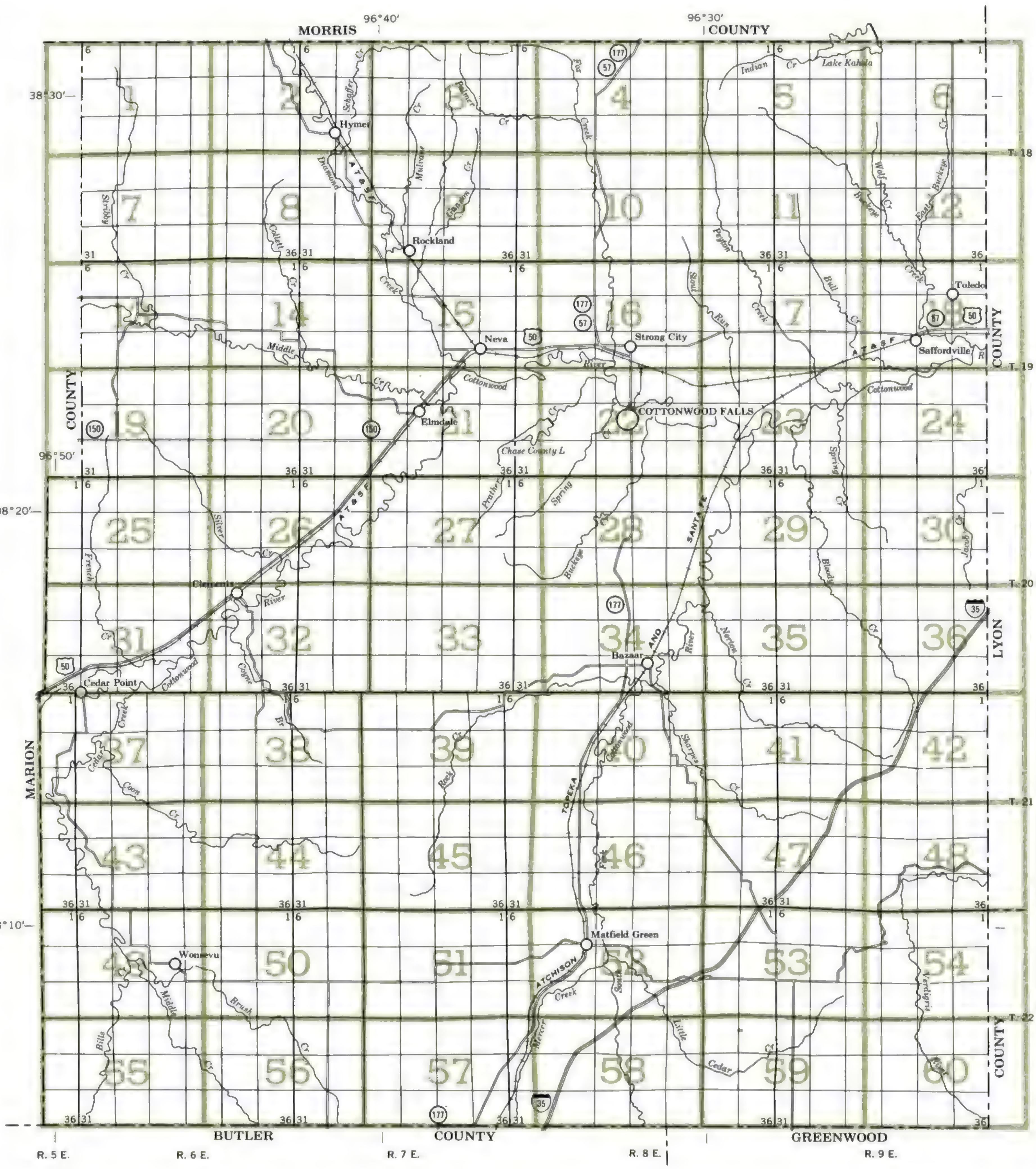
GENERAL SOIL MAP

CHASE COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Original text from each individual map sheet read:
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1970 aerial photography. Positions of 5,000 foot grid ticks are approximate and based on the Kansas coordinate system, south zone. Land division corners are approximately positioned on this map.

N

INDEX TO MAP SHEETS

CHASE COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads
- Divided
- Good motor
- Poor motor
- Trail

Highway markers
- National Interstate
- U. S.
- State or county

Railroads
- Single track
- Multiple track
- Abandoned

Bridges and crossings
- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings
- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Windmill

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport ...
- Land survey division corners

DRAINAGE

Streams, double-line
- Perennial
- Intermittent

Streams, single-line
- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds
- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments
- Bedrock
- Other

Short steep slope

Prominent peak

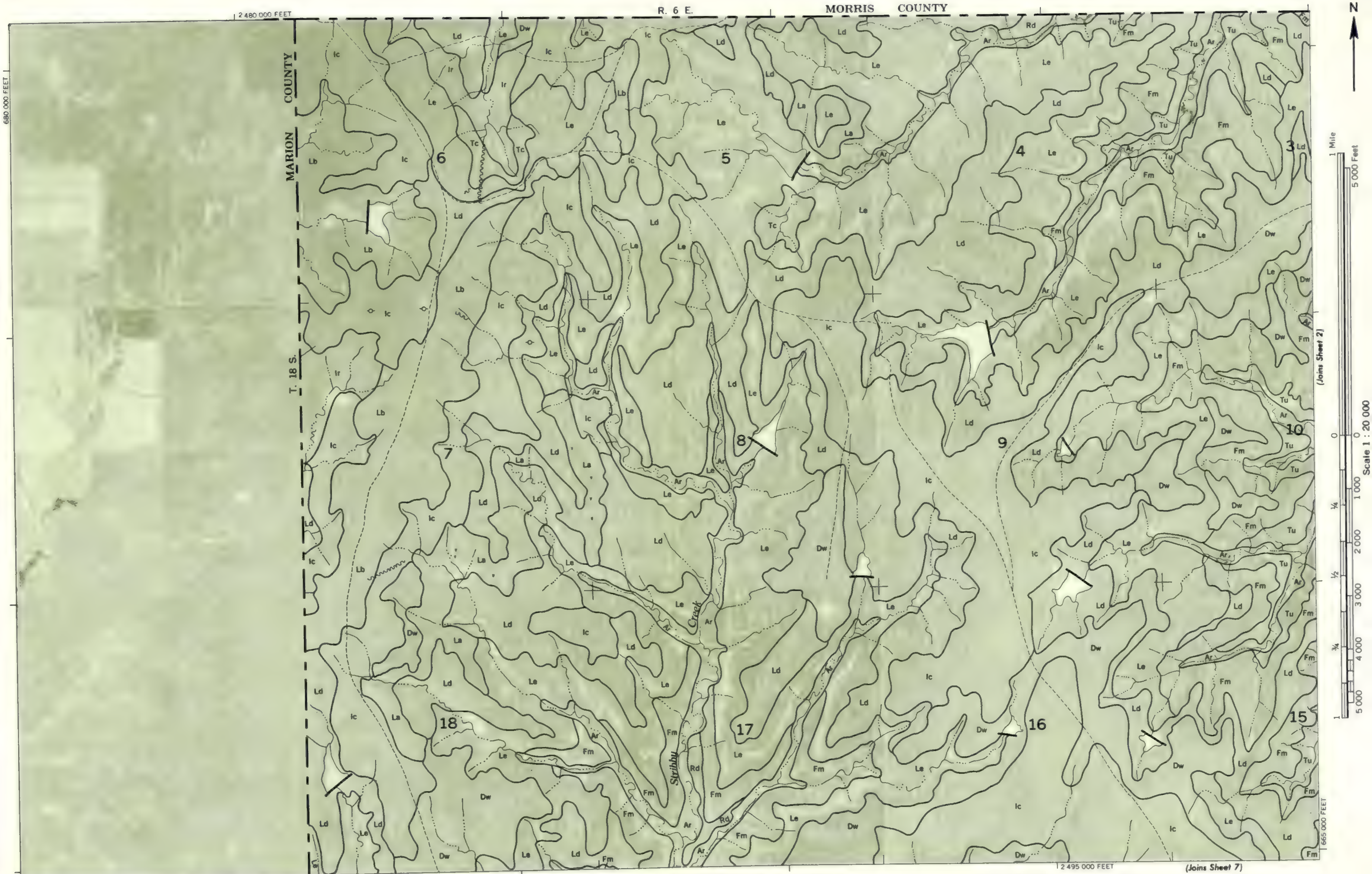
Depressions (Large, Small)
- Crossable with tillage implements
- Not crossable with tillage implements
- Contains water most of the time

SOIL SURVEY DATA

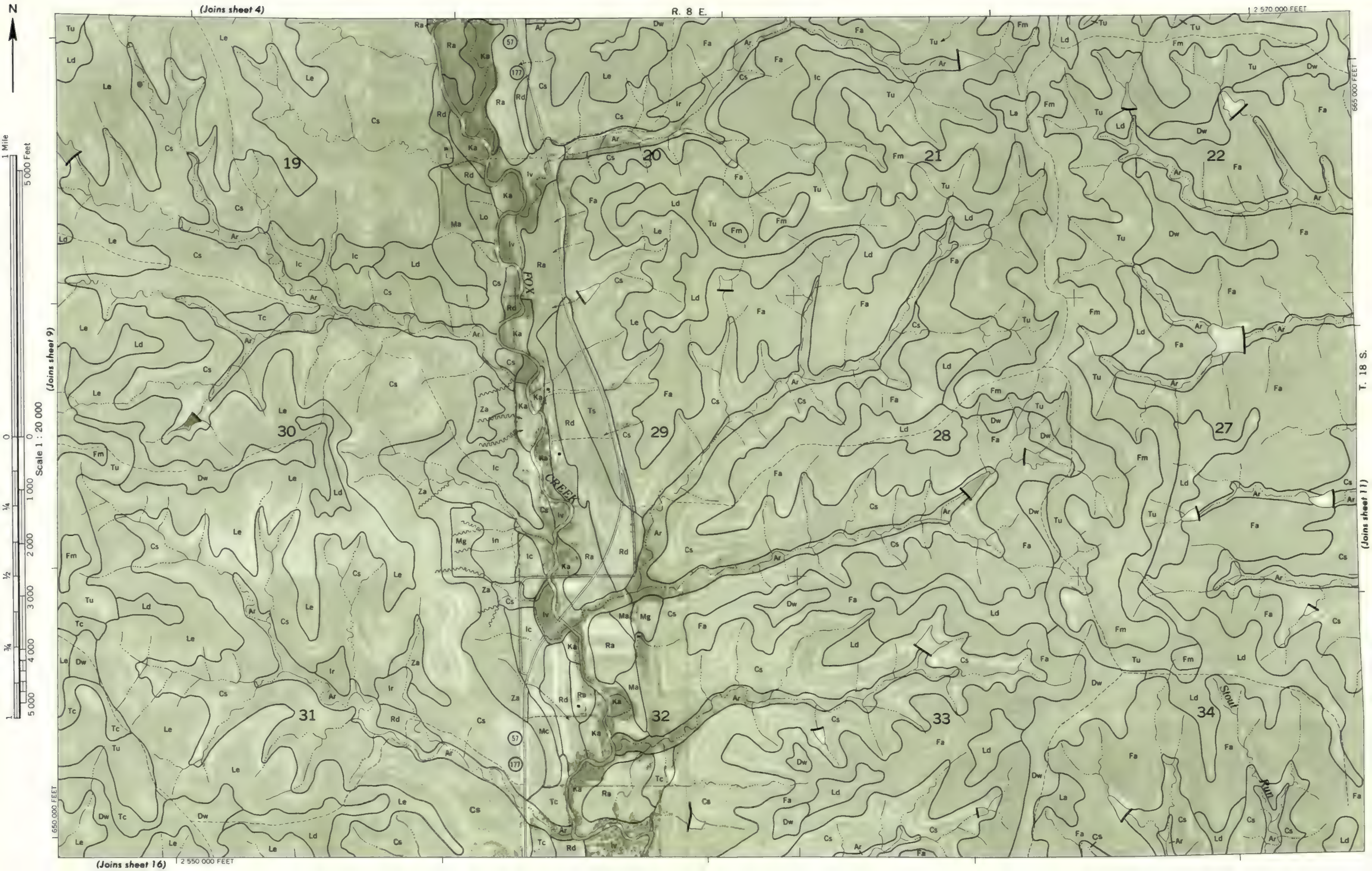
- Soil boundary and symbol (Dx)
- Gravel
- Stoniness: Stony; Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully
- Borrow pit (B.P.)
- Solometz Spots

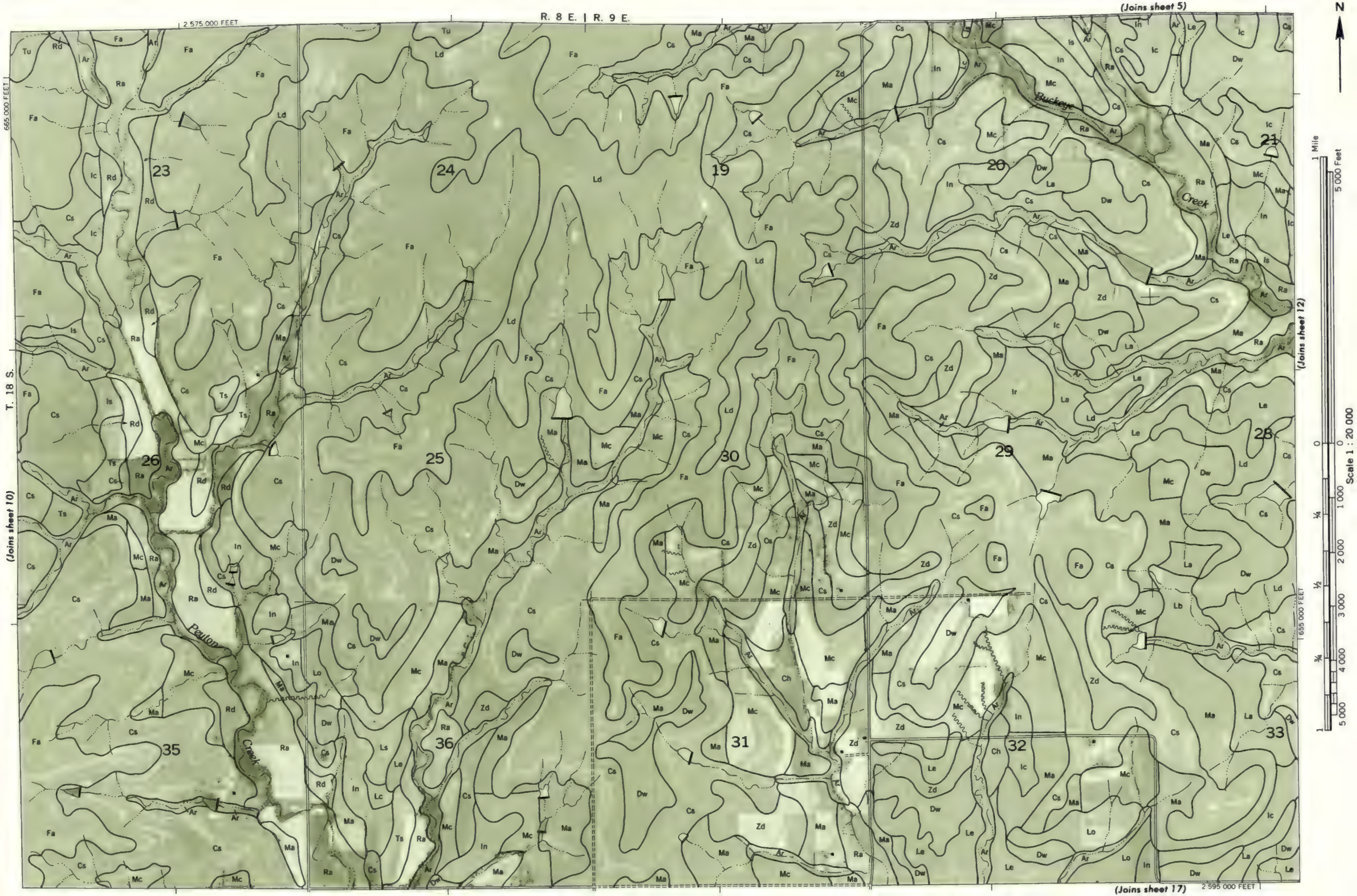
SOIL LEGEND

SYMBOL	NAME
Ar	Alluvial land and Reading soils
Ch	Chase silty clay loam
Cs	Clime-Sogn complex
Dw	Dwight silt loam, 1 to 3 percent slopes
Fa	Florence-Labette complex
Fm	Florence-Matfield cherty silt loams
Ic	Irwin silty clay loam, 1 to 3 percent slopes
In	Irwin silty clay loam, 1 to 3 percent slopes, eroded
Ir	Irwin silty clay loam, 3 to 5 percent slopes
Is	Irwin silty clay loam, 3 to 5 percent slopes, eroded
Iv	Ivan silt loam
Ka	Kahola silt loam
La	Labette silty clay loam, 1 to 3 percent slopes
Lb	Labette silty clay loam, 3 to 5 percent slopes
Lc	Labette silty clay loam, 2 to 5 percent slopes, eroded
Ld	Labette-Dwight complex, 1 to 3 percent slopes
Le	Labette-Sogn complex
Lm	Ladysmith silty clay loam, 0 to 1 percent slopes
Lo	Ladysmith silty clay loam, 1 to 3 percent slopes
Ls	Ladysmith silty clay loam, 1 to 3 percent slopes, eroded
Ma	Martin silty clay loam, 2 to 6 percent slopes
Mc	Martin silty clay loam, 2 to 6 percent slopes, eroded
Mg	Martin-Gullied land complex
Om	Olpe-Smolan complex
Os	Osage silty clay
Ra	Reading silt loam, 0 to 1 percent slopes
Rd	Reading silt loam, 1 to 3 percent slopes
Re	Reading soils, 6 to 12 percent slopes, eroded
Sm	Smolan silty clay loam, 2 to 6 percent slopes
So	Solomon silty clay
St	Stony steep land
Tc	Tully silty clay loam, 3 to 7 percent slopes
Ts	Tully silty clay loam, 3 to 7 percent slopes, eroded
Tu	Tully cherty silty clay loam, 5 to 15 percent slopes
Za	Zaar silty clay, 3 to 7 percent slopes
Zd	Zaar-Dwight complex, 1 to 3 percent slopes

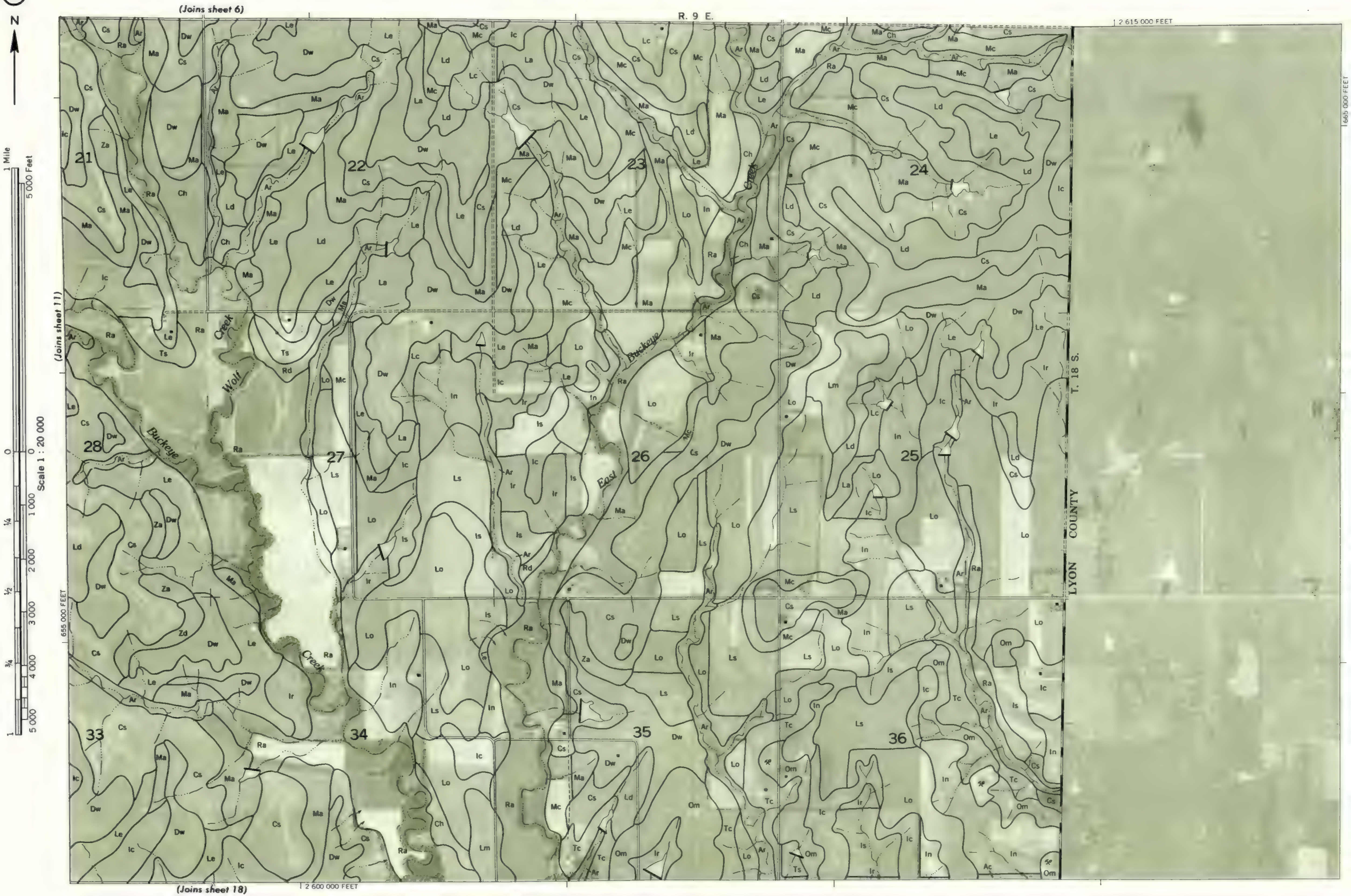

2 480 000 FEET
R. 6 E.
MORRIS COUNTY
N
MARION COUNTY
T. 18 S.
680 000 FEET
Stribby Creek
(Joins Sheet 2)
(Joins Sheet 7)
665 000 FEET
2 495 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000

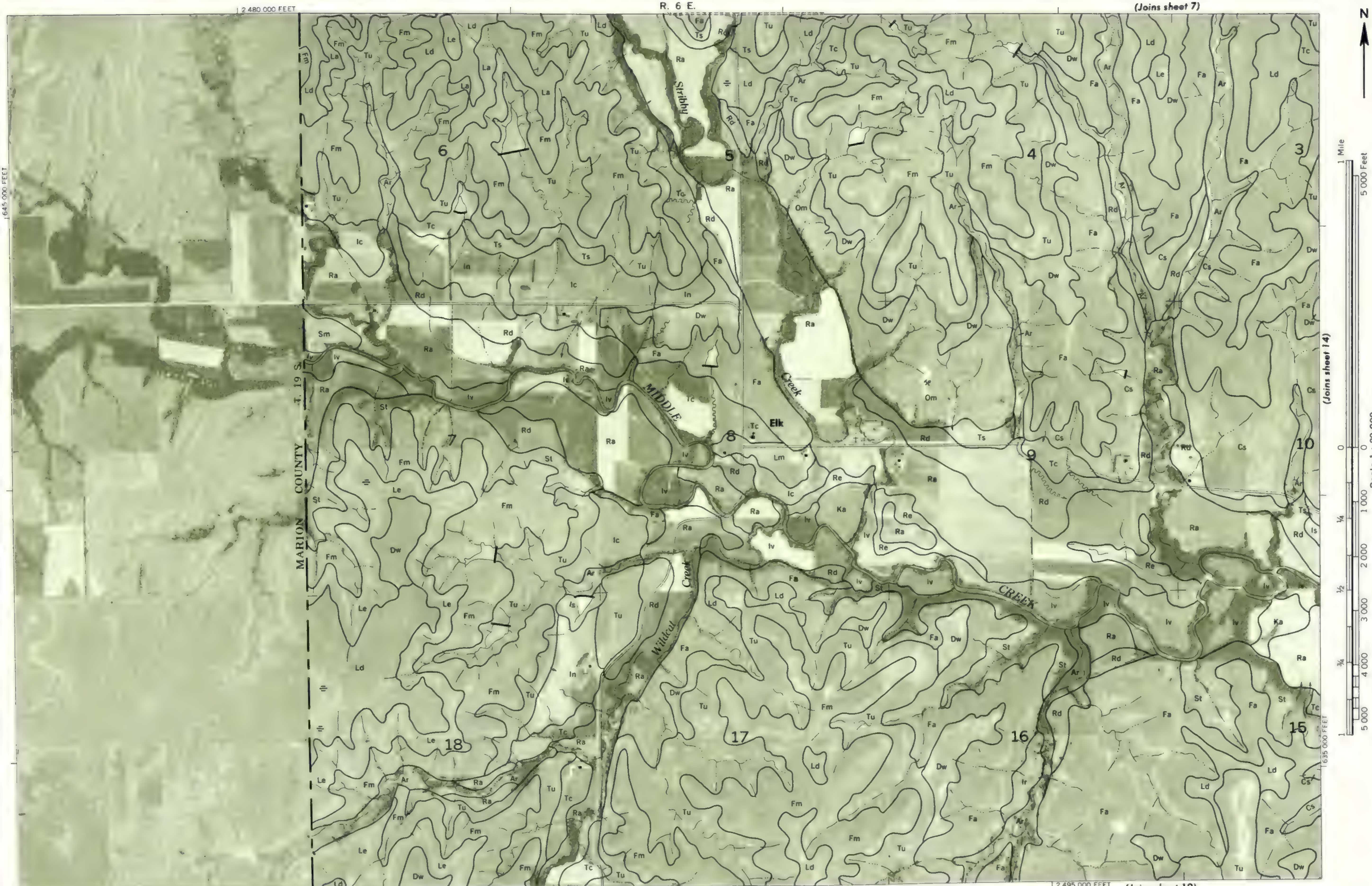
CHASE COUNTY, KANSAS — SHEET NUMBER 10



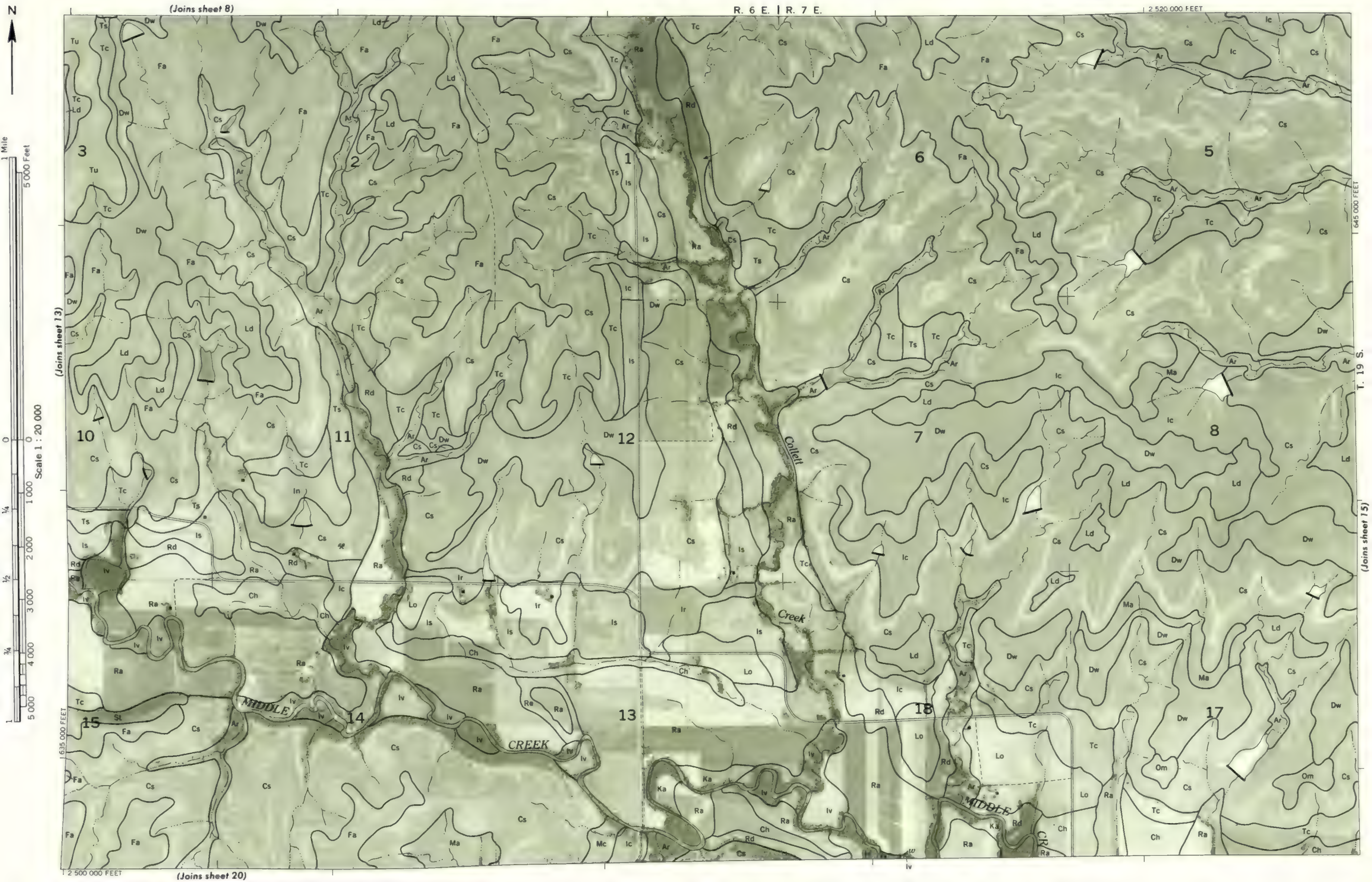

(Joins sheet 5)
R. 8 E. | R. 9 E.
2 575 000 FEET
665 000 FEET
T. 18 S.
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 17)
2 595 000 FEET
655 000 FEET
Buckeye Creek
Peyton Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
N
1 Mile
5 000 Feet
Scale 1 : 20 000

CHASE COUNTY, KANSAS — SHEET NUMBER 12

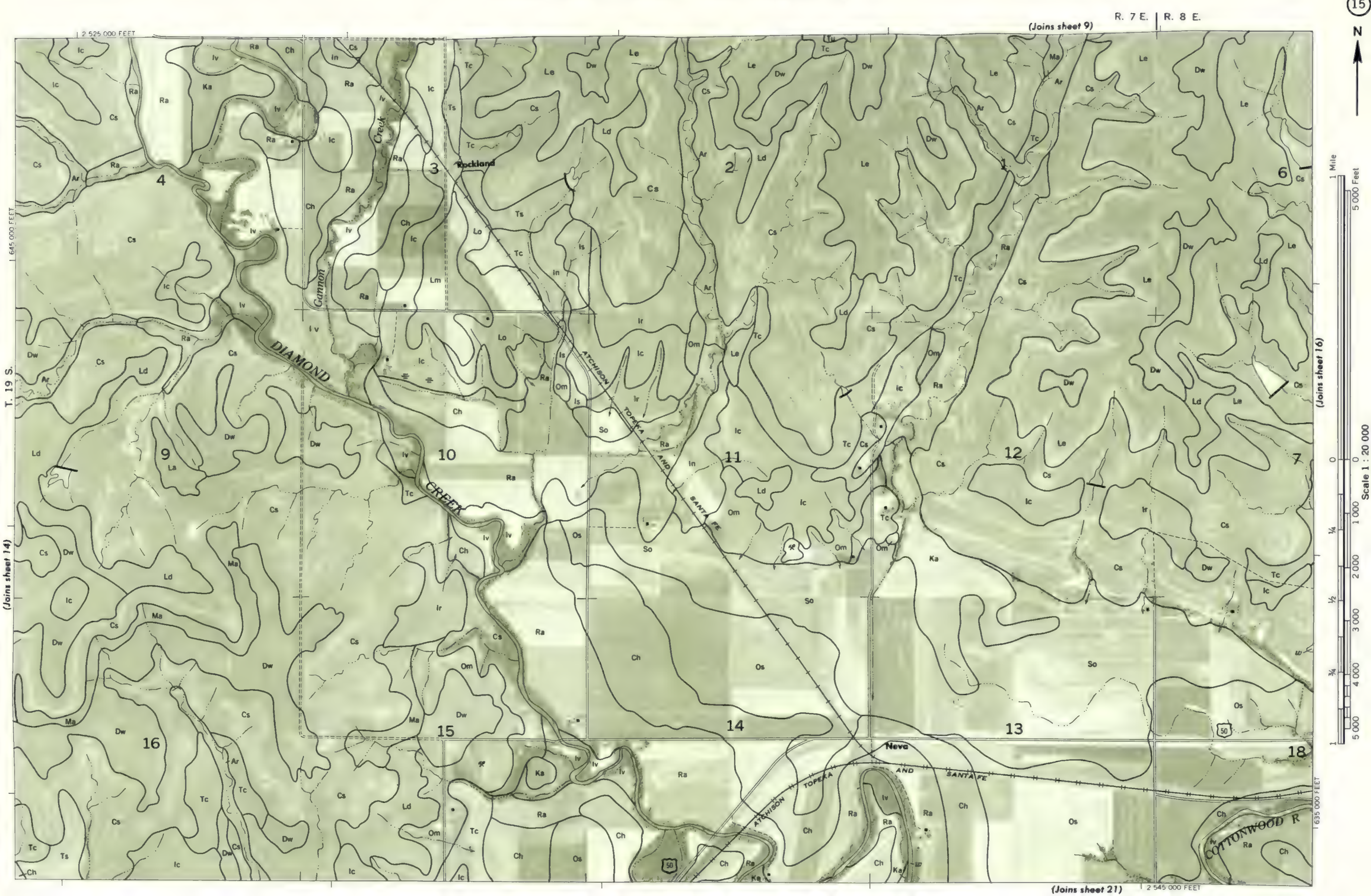



2 480 000 FEET
R. 6 E.
(Joins sheet 7)
N
1 645 000 FEET
T. 19 S.
MARION COUNTY
Stribby
Creek
MIDDLE
Elk
Wildcat
Creek
CREEK
(Joins sheet 14)
1 Mile
5 000 Feet
Scale 1 : 20 000
1 635 000 FEET
2 495 000 FEET
(Joins sheet 19)

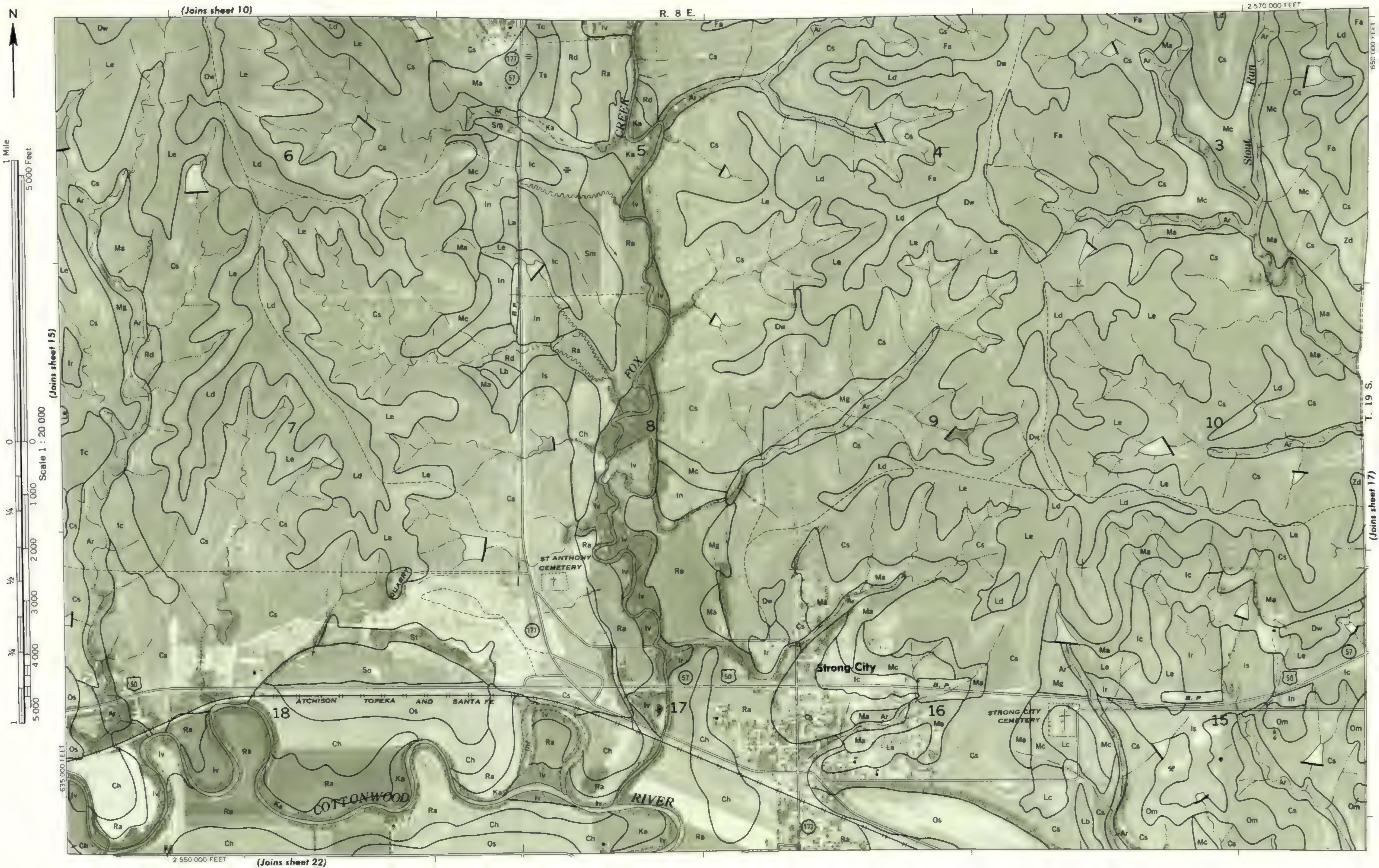
CHASE COUNTY, KANSAS — SHEET NUMBER 14

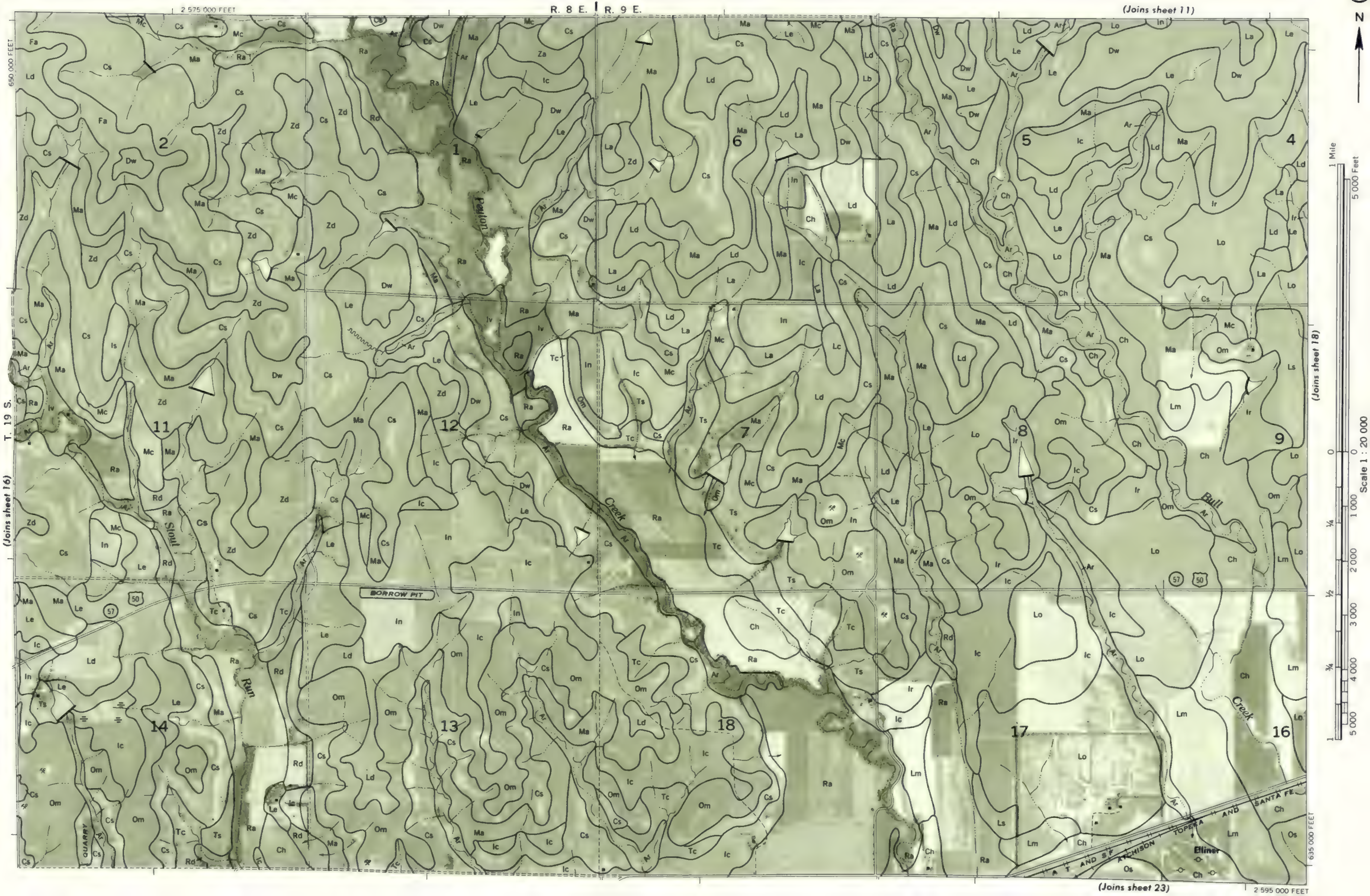


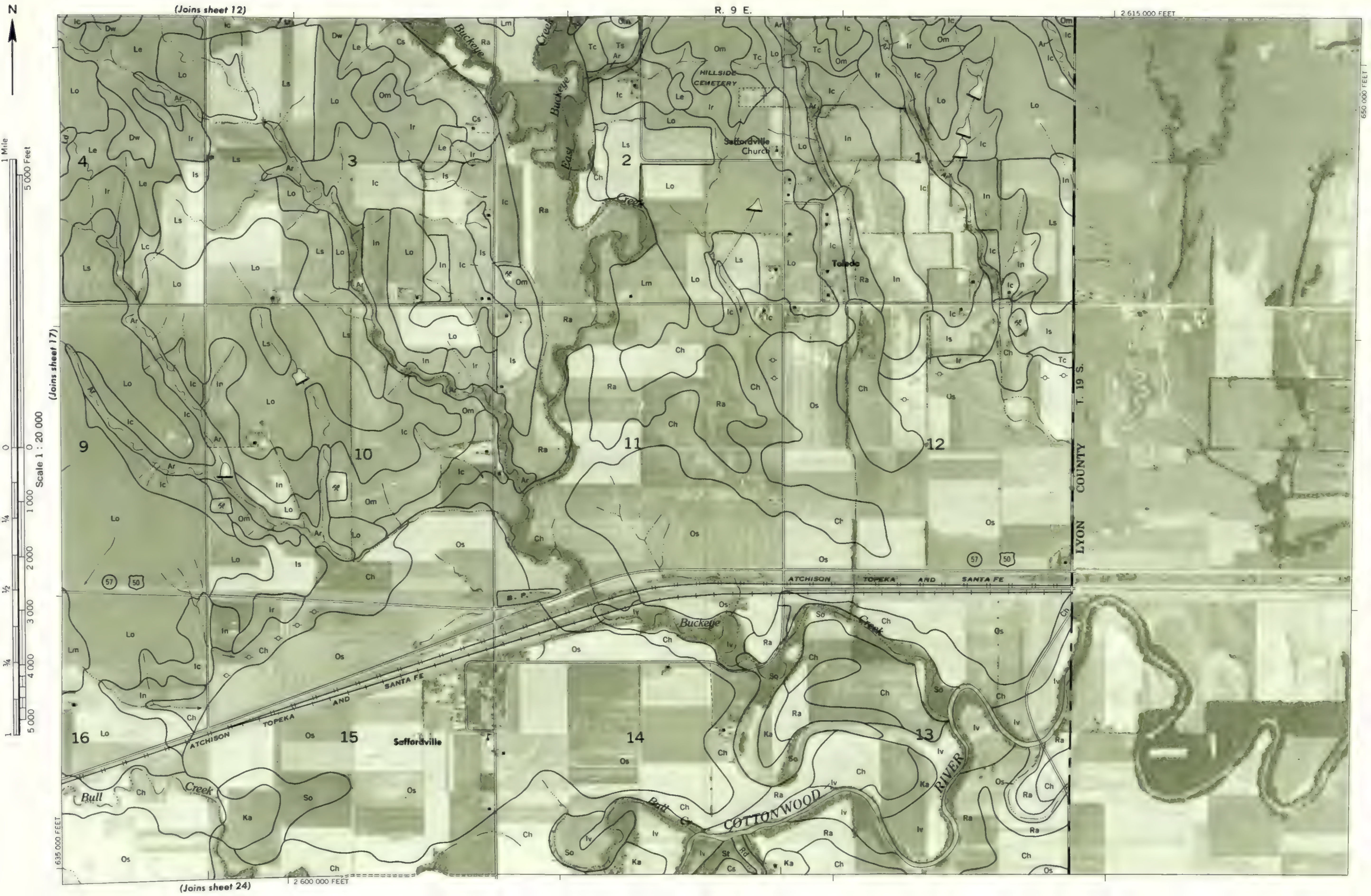
CHASE COUNTY, KANSAS _ SHEET NUMBER 15



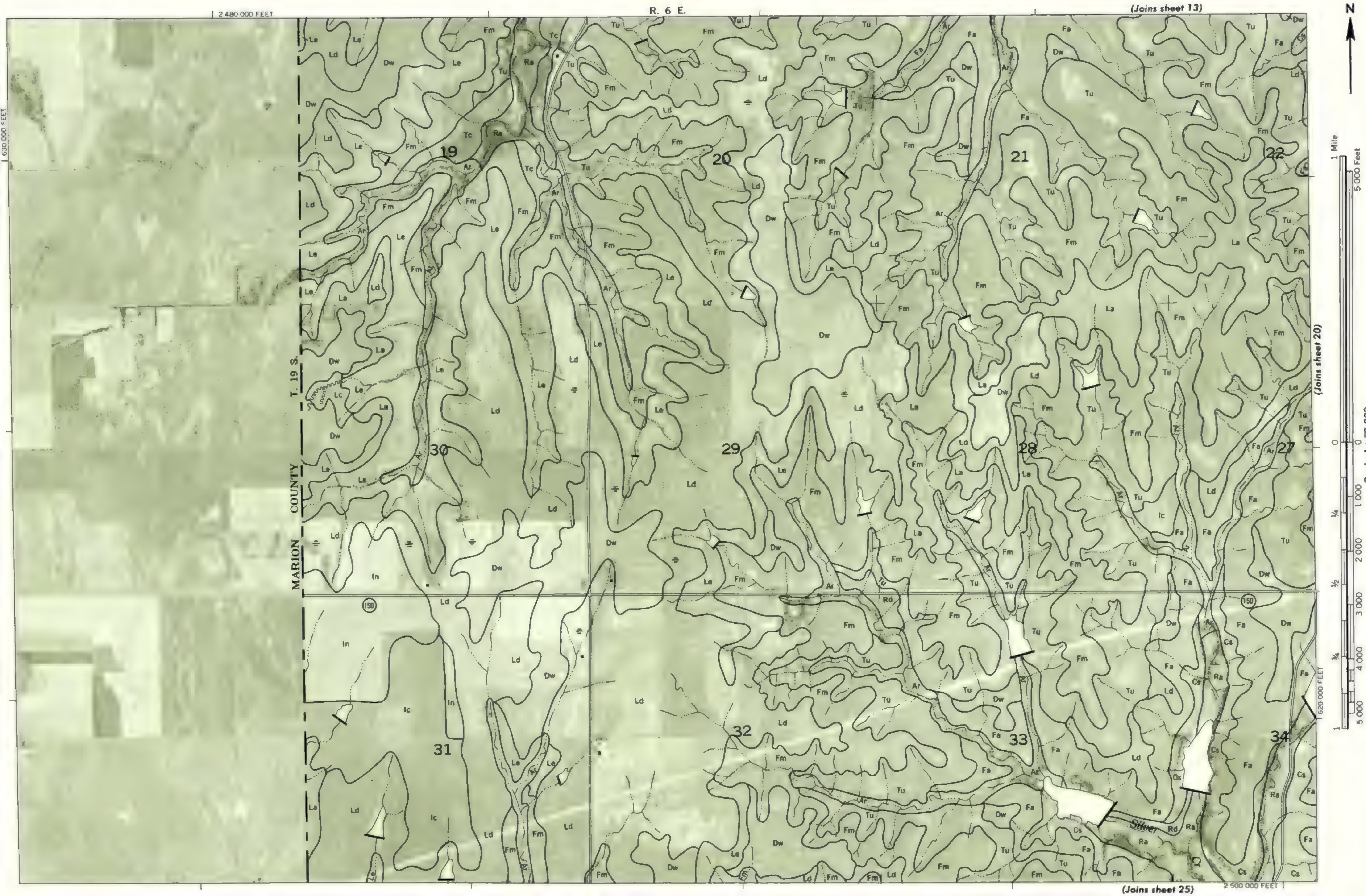
CHASE COUNTY, KANSAS — SHEET NUMBER 16

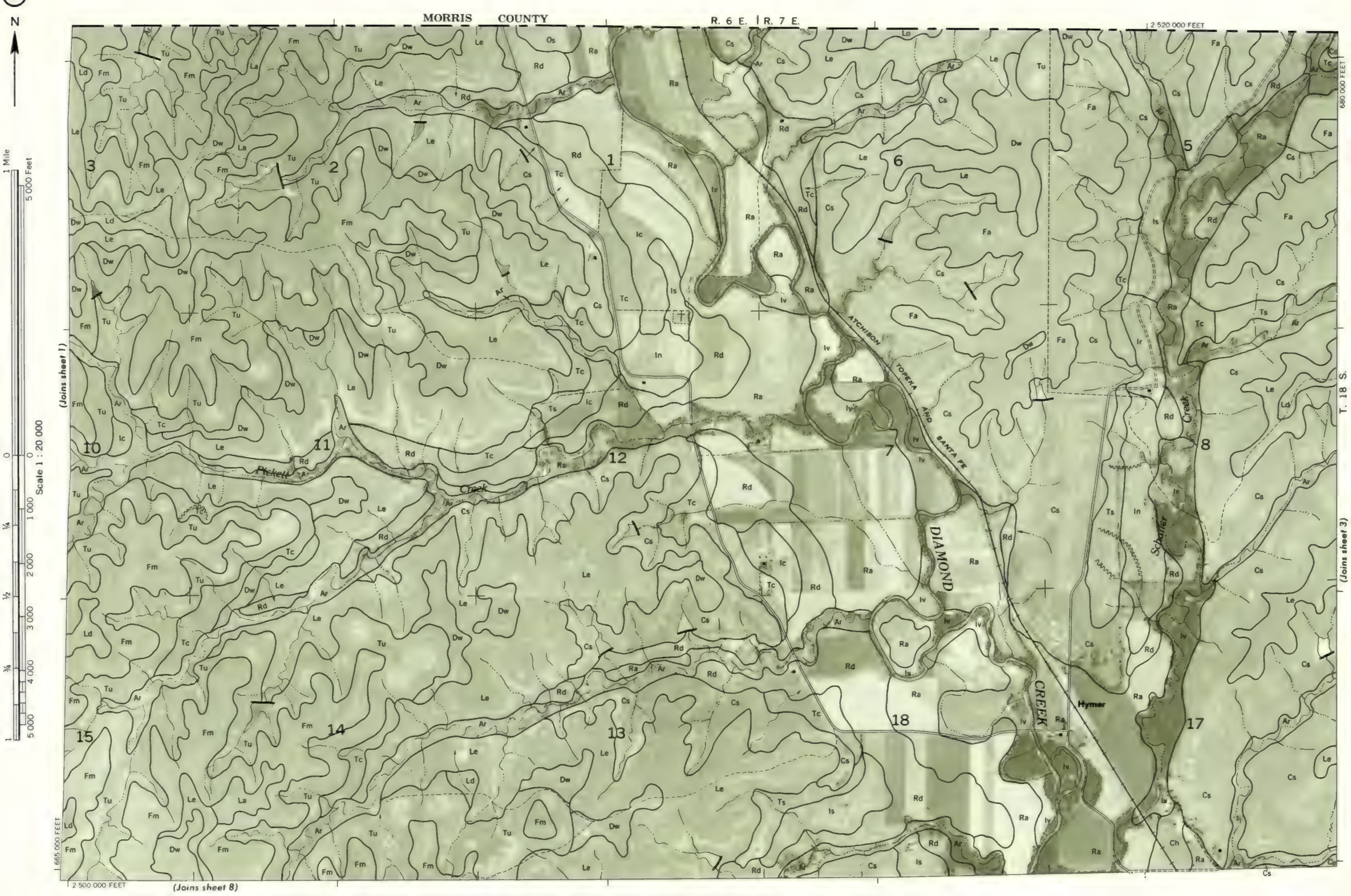



17
N
R. 8 E. | R. 9 E.
(Joins sheet 11)
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 23)
T. 19 S.
2 575 000 FEET
650 000 FEET
635 000 FEET
2 595 000 FEET
BORROW PIT
Peyton
Creek
Stout
Run
Bull
Creek
QUARRY
ATCHISON TOPEKA AND SANTA FE
A T AND S F
Scale 1 : 20 000
1 Mile
5 000 Feet

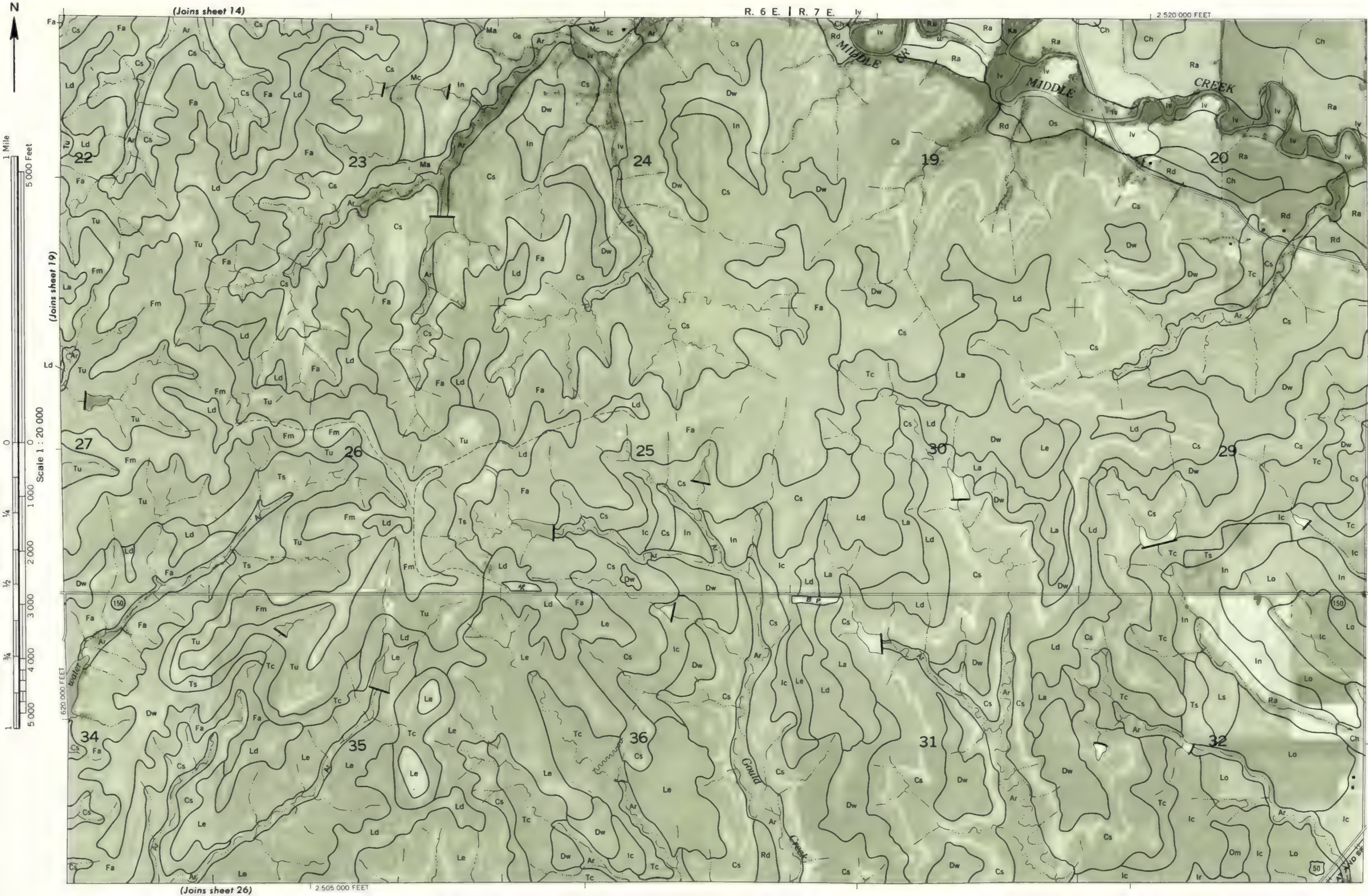

N
1 Mile
5 000 Feet
Scale 1 : 20 000
(Joins sheet 12)
(Joins sheet 17)
(Joins sheet 24)
R. 9 E.
T. 19 S.
2 615 000 FEET
650 000 FEET
635 000 FEET
2 600 000 FEET
LYON COUNTY
HILLSIDE CEMETERY
Saffordville Church
Toledo
Saffordville
Buckeye Creek
East Buckeye Creek
Bull Creek
COTTONWOOD RIVER
ATCHISON TOPEKA AND SANTA FE
1
2
3
4
9
10
11
12
13
14
15
16

CHASE COUNTY, KANSAS — SHEET NUMBER 19

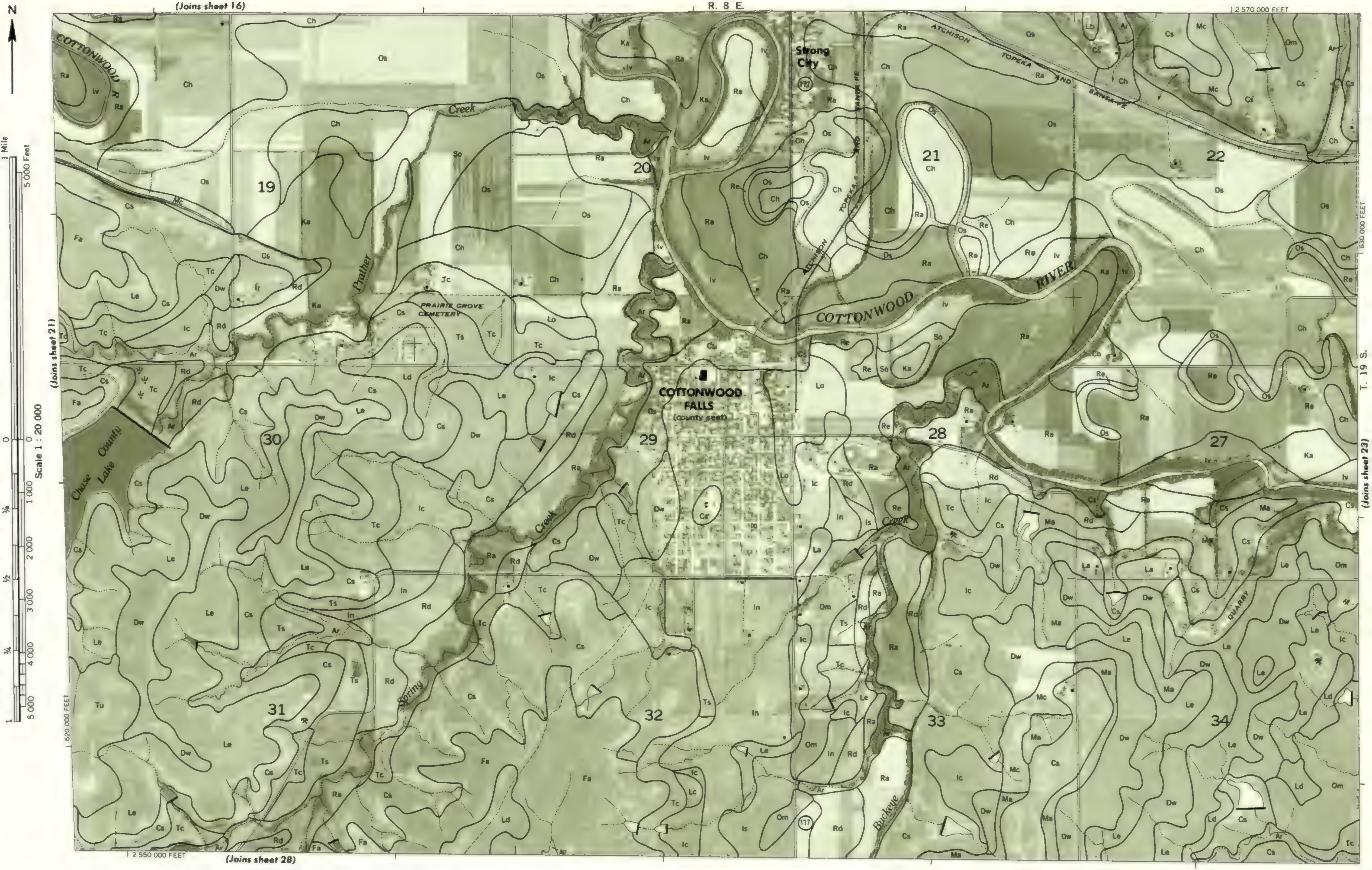


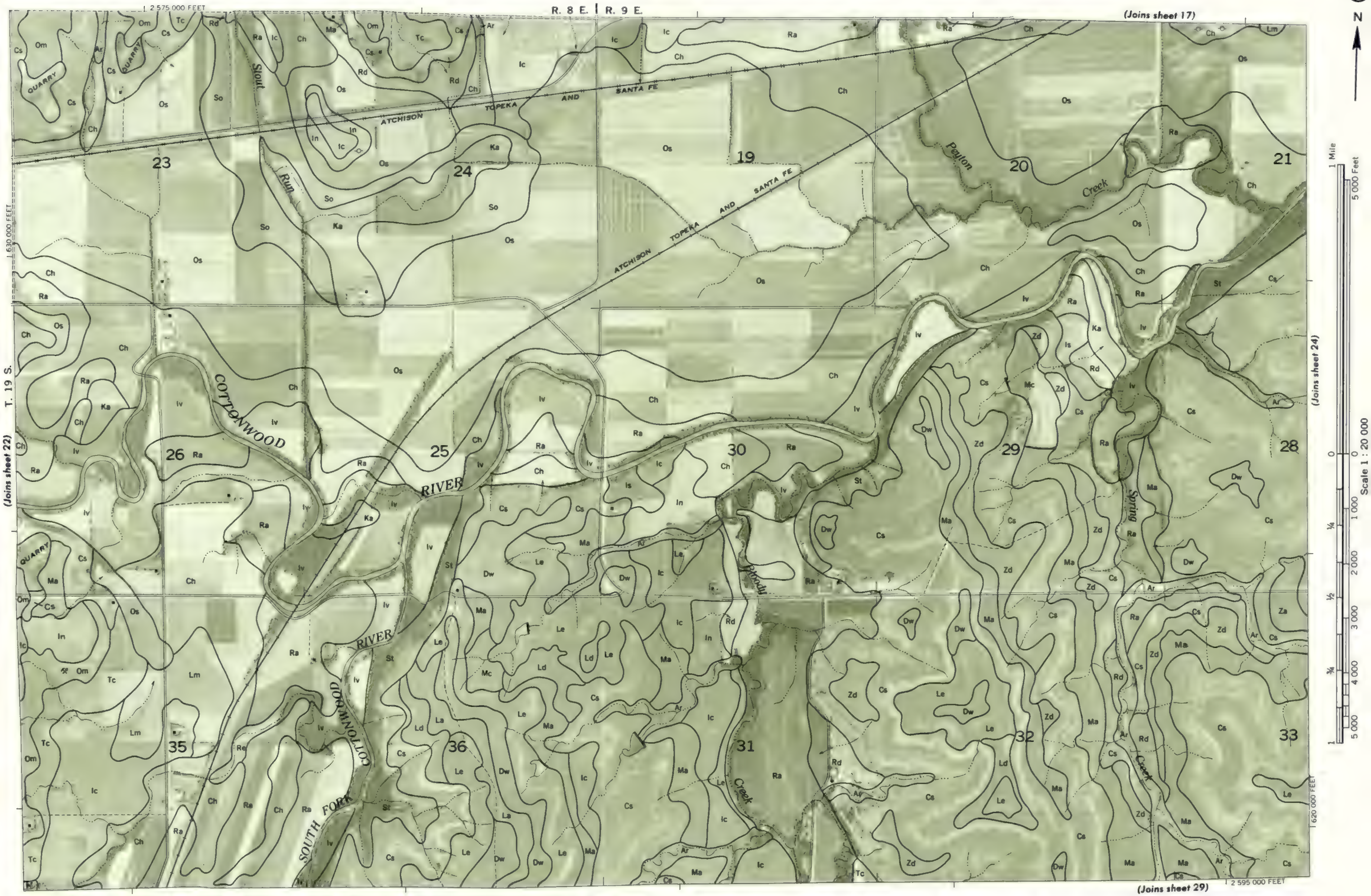

N
MORRIS COUNTY
R. 6 E. | R. 7 E.
2 520 000 FEET
680 000 FEET
665 000 FEET
2 500 000 FEET
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)
T. 18 S.
ATCHISON TOPEKA AND SANTA FE
DIAMOND CREEK
Pickett Creek
Schaffer Creek
Hymer
1 Mile
5 000 Feet
Scale 1 : 20 000

CHASE COUNTY, KANSAS — SHEET NUMBER 20

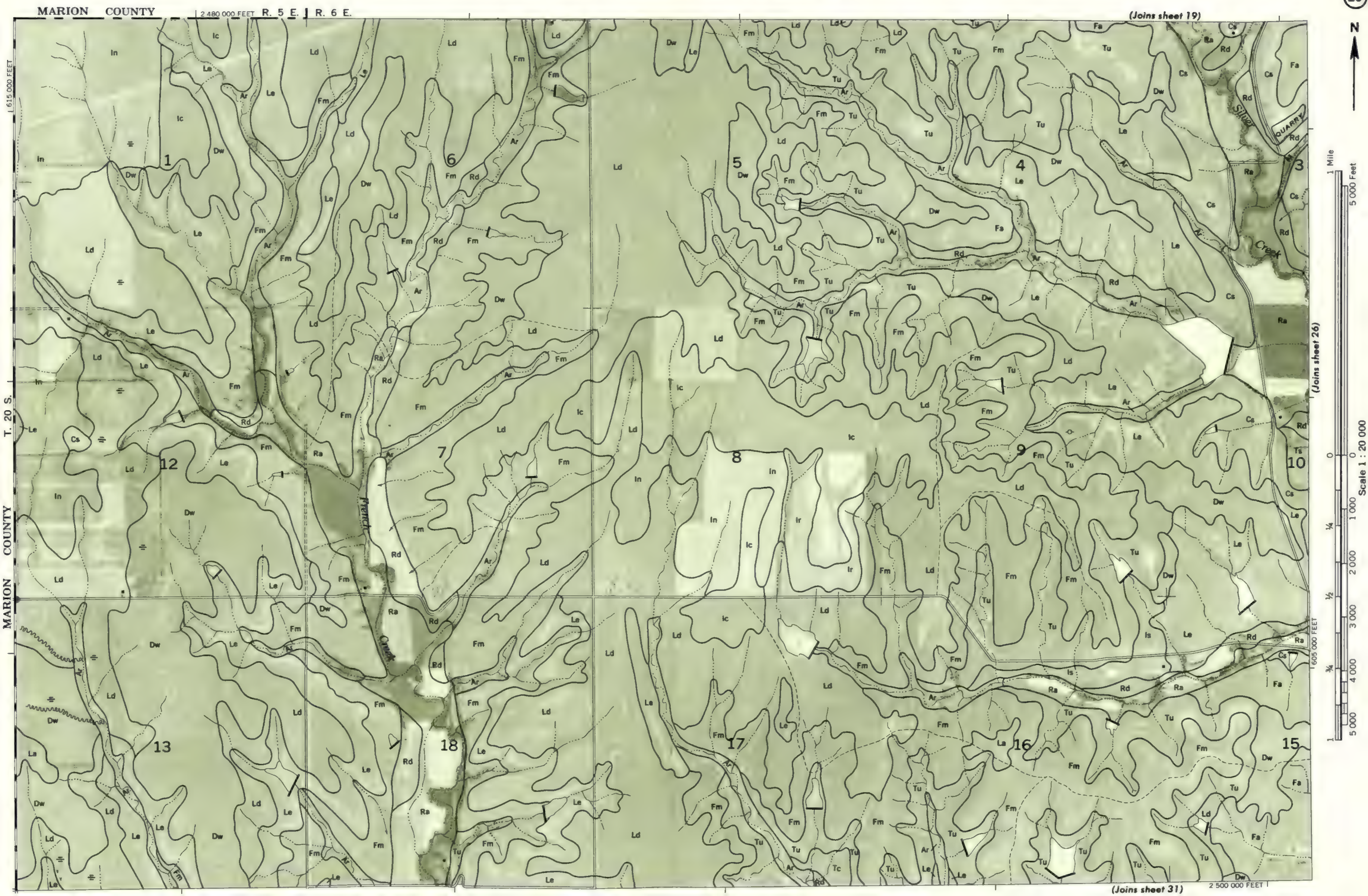


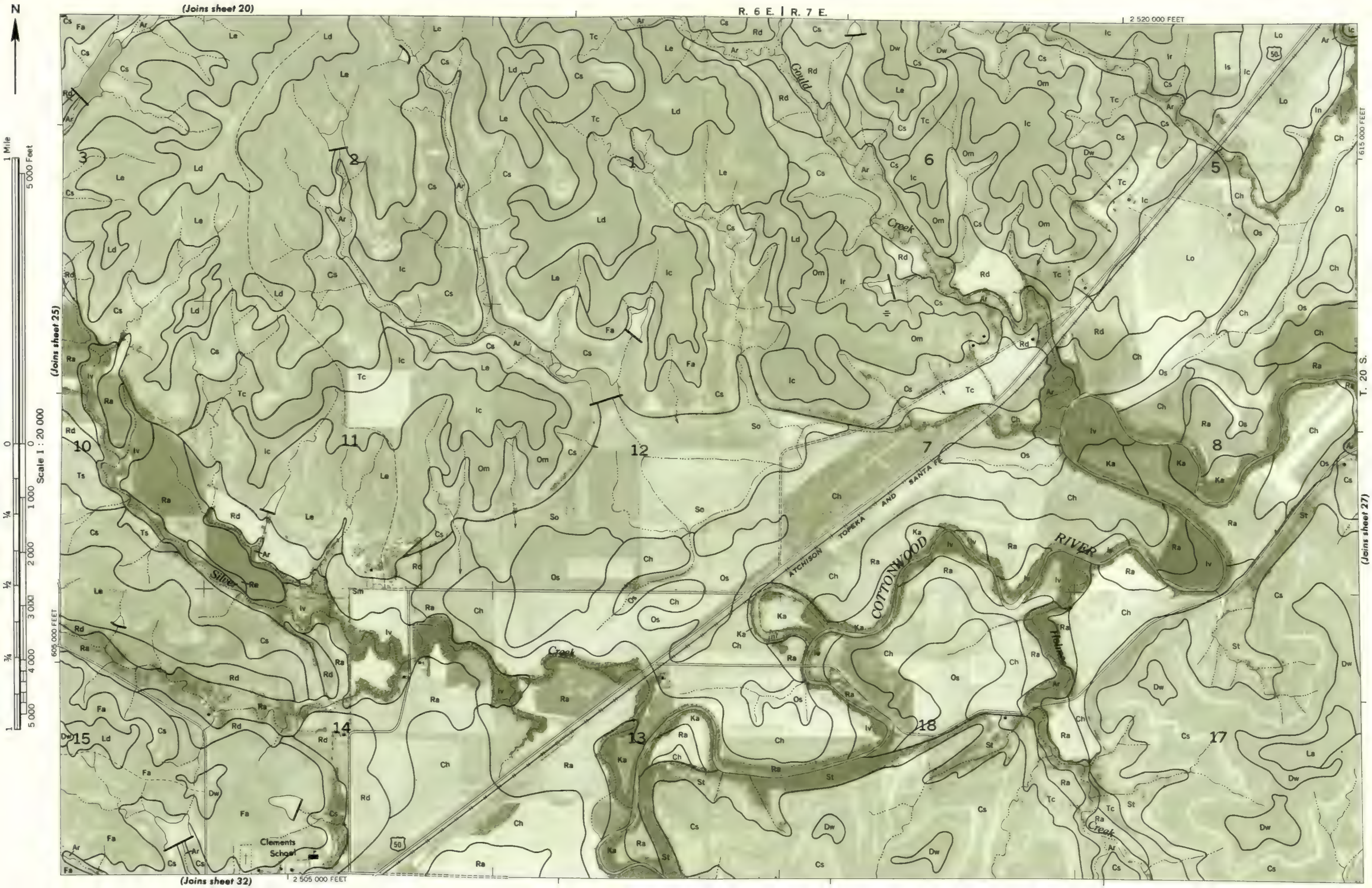
CHASE COUNTY, KANSAS — SHEET NUMBER 21

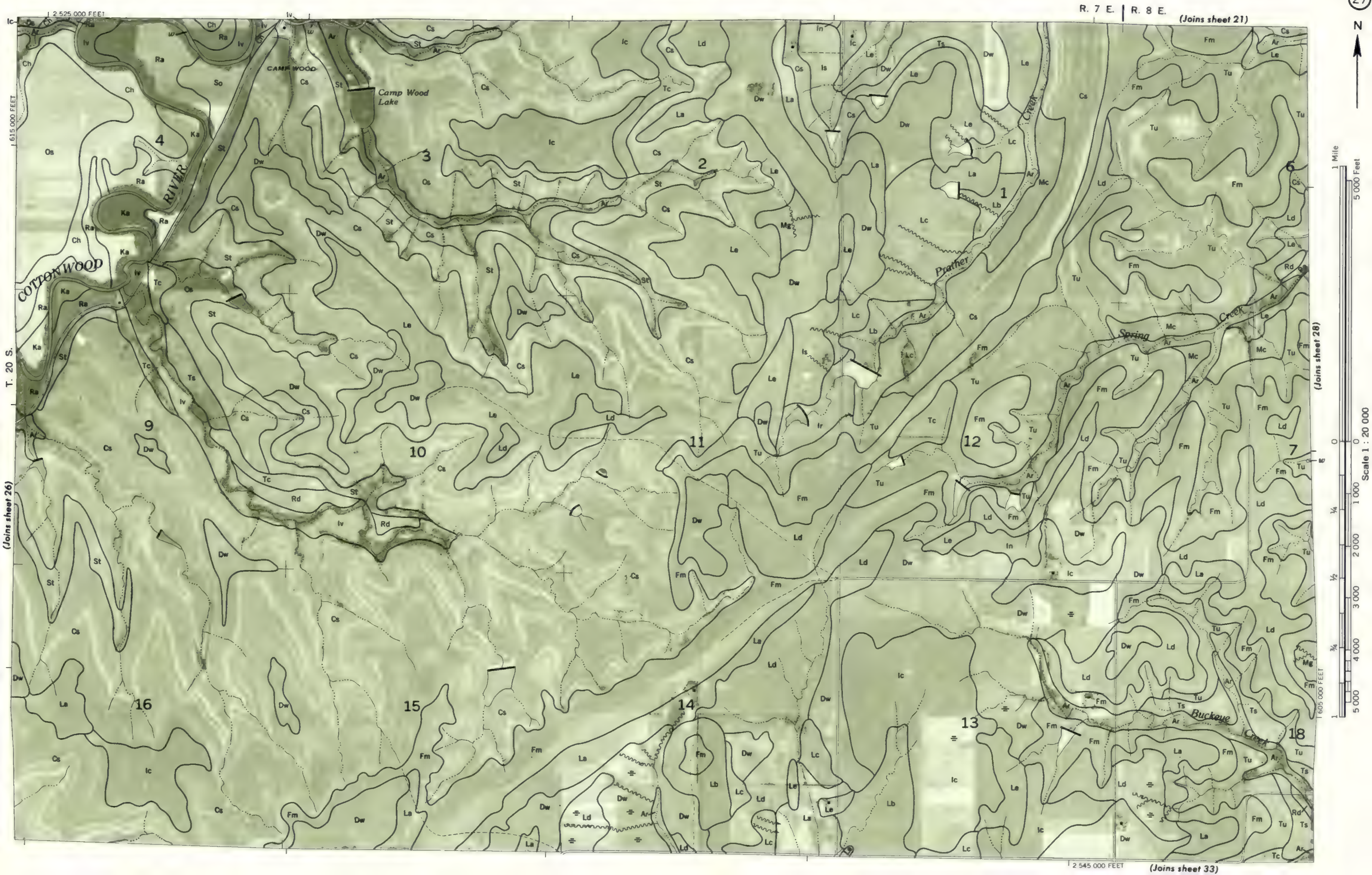

N
(Joins sheet 16)
R. 8 E.
2 570 000 FEET
Strong City
COTTONWOOD R
Creek
Prather
PRAIRIE GROVE CEMETERY
ATCHISON TOPEKA AND SANTA FE
COTTONWOOD RIVER
COTTONWOOD FALLS
(county seat)
Chase County Lake
Spring
Creek
Buckeye
QUARRY
(Joins sheet 21)
(Joins sheet 23)
T. 19 S.
630 000 FEET
620 000 FEET
2 550 000 FEET
(Joins sheet 28)
1 Mile
5 000 Feet
Scale 1 : 20 000
19
20
21
22
27
28
29
30
31
32
33
34


2 575 000 FEET
R. 8 E. | R. 9 E.
(Joins sheet 17)
N
1 Mile
5 000 Feet
Scale 1 : 20 000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
630 000 FEET
T. 19 S.
(Joins sheet 22)
(Joins sheet 24)
620 000 FEET
2 595 000 FEET
(Joins sheet 29)
ATCHISON TOPEKA AND SANTA FE
ATCHISON TOPEKA AND SANTA FE
COTTONWOOD RIVER
COTTONWOOD RIVER
SOUTH FORK COTTONWOOD
Stout Run
Peyton Creek
Spring Creek
Bloody Creek
QUARRY
QUARRY
QUARRY
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

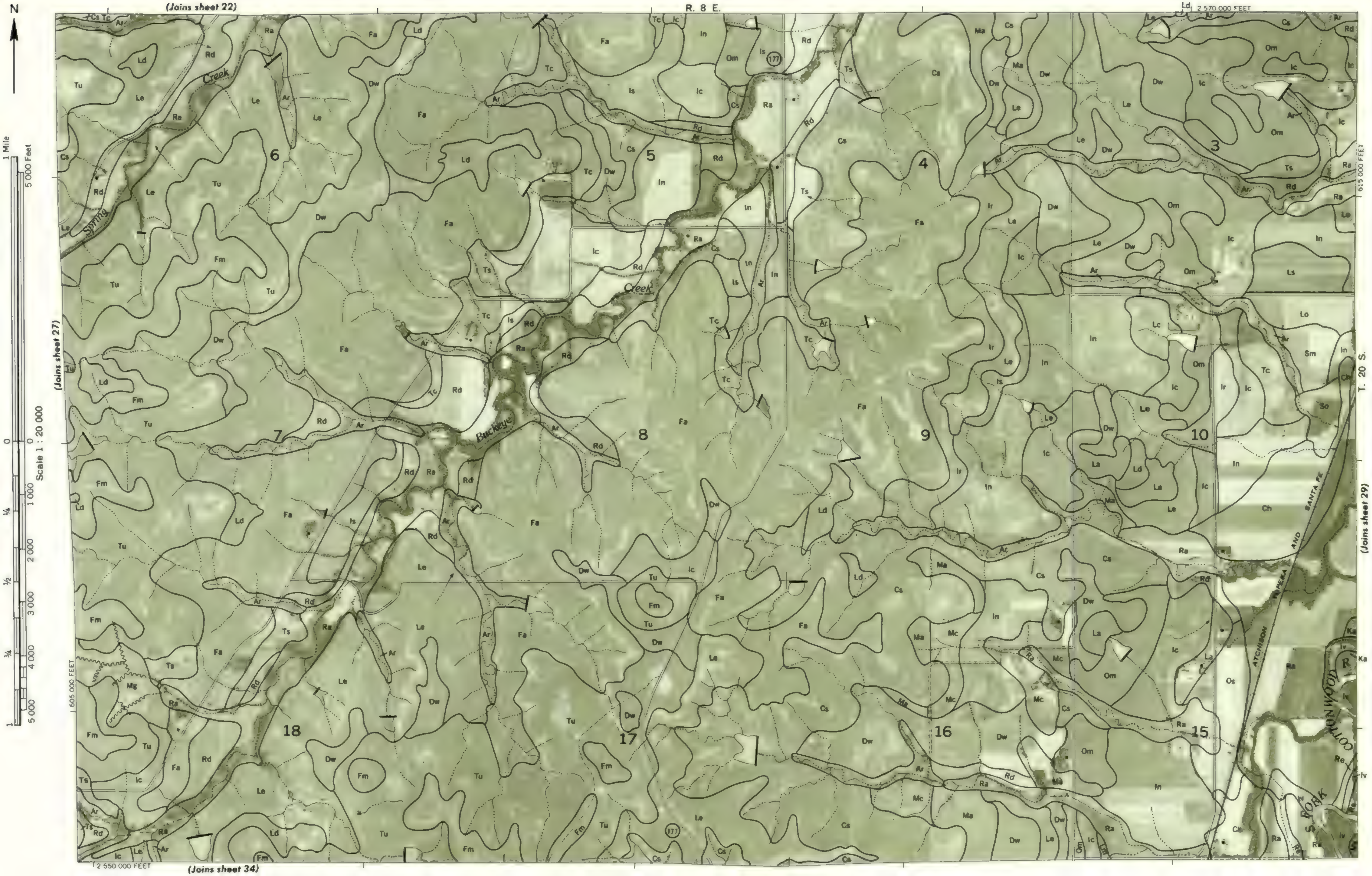

N
1 Mile
5 000 Feet
Scale 1 : 20 000
(Joins sheet 18)
R. 9 E.
2 615 000 FEET
635 000 FEET
(Joins sheet 23)
T. 19 S.
LYON COUNTY
(Joins sheet 30)
2 600 000 FEET
620 000 FEET
COTTONWOOD
RIVER
Bull
Creek
Jacob
Creek
21
22
23
24
25
26
27
28
33
34
35
36

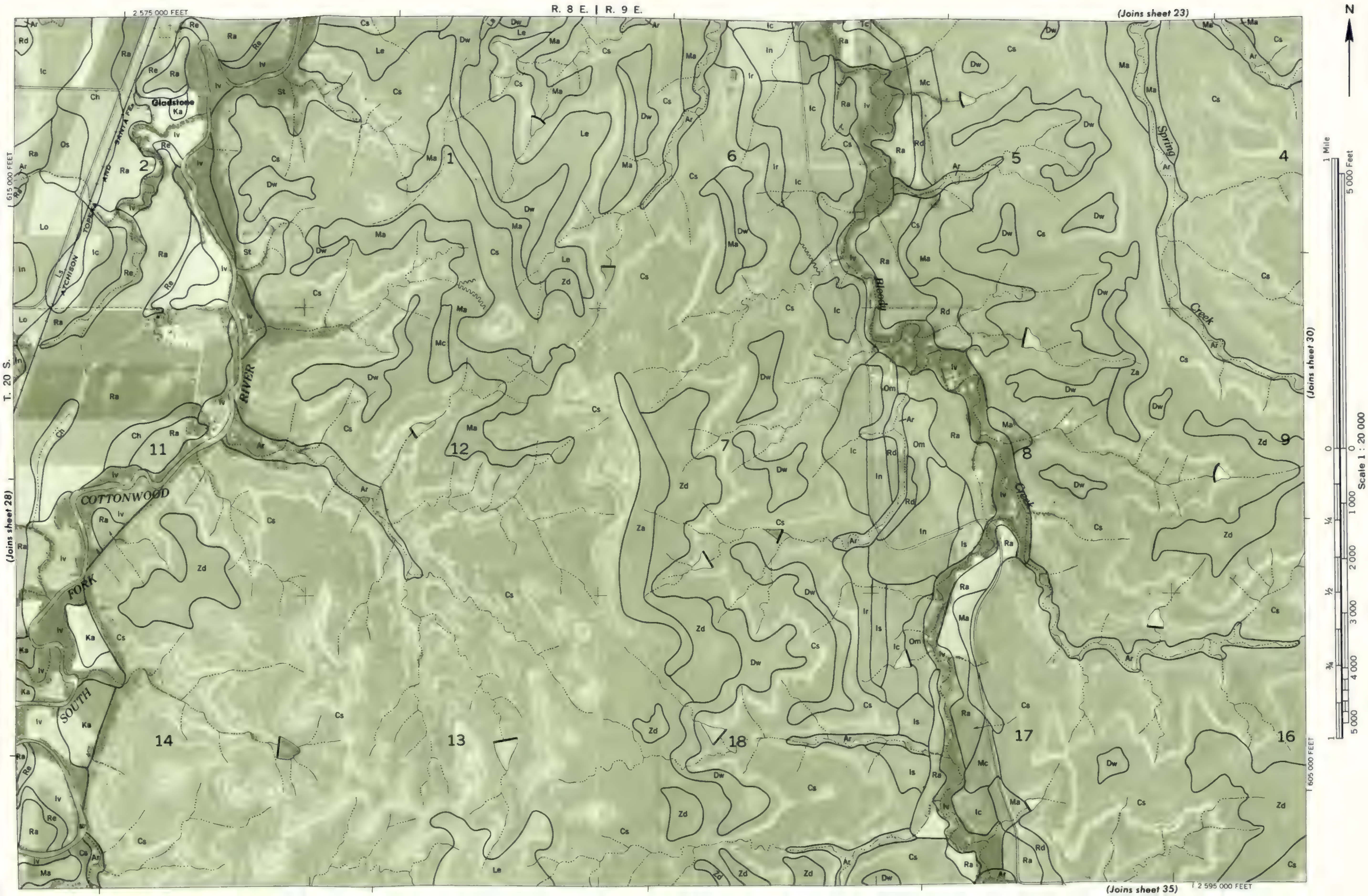

MARION COUNTY
2 480 000 FEET
R. 5 E.
R. 6 E.
(Joins sheet 19)
N
1 615 000 FEET
T. 20 S.
MARION COUNTY
(Joins sheet 26)
(Joins sheet 31)
2 500 000 FEET
1 605 000 FEET
QUARRY
Silver Creek
French Creek
1 Mile
5 000 Feet
Scale 1 : 20 000
0
1/4
1/2
3/4
1
0
1 000
2 000
3 000
4 000
5 000
1
2
3
4
5
6
7
8
9
10
12
13
15
16
17
18

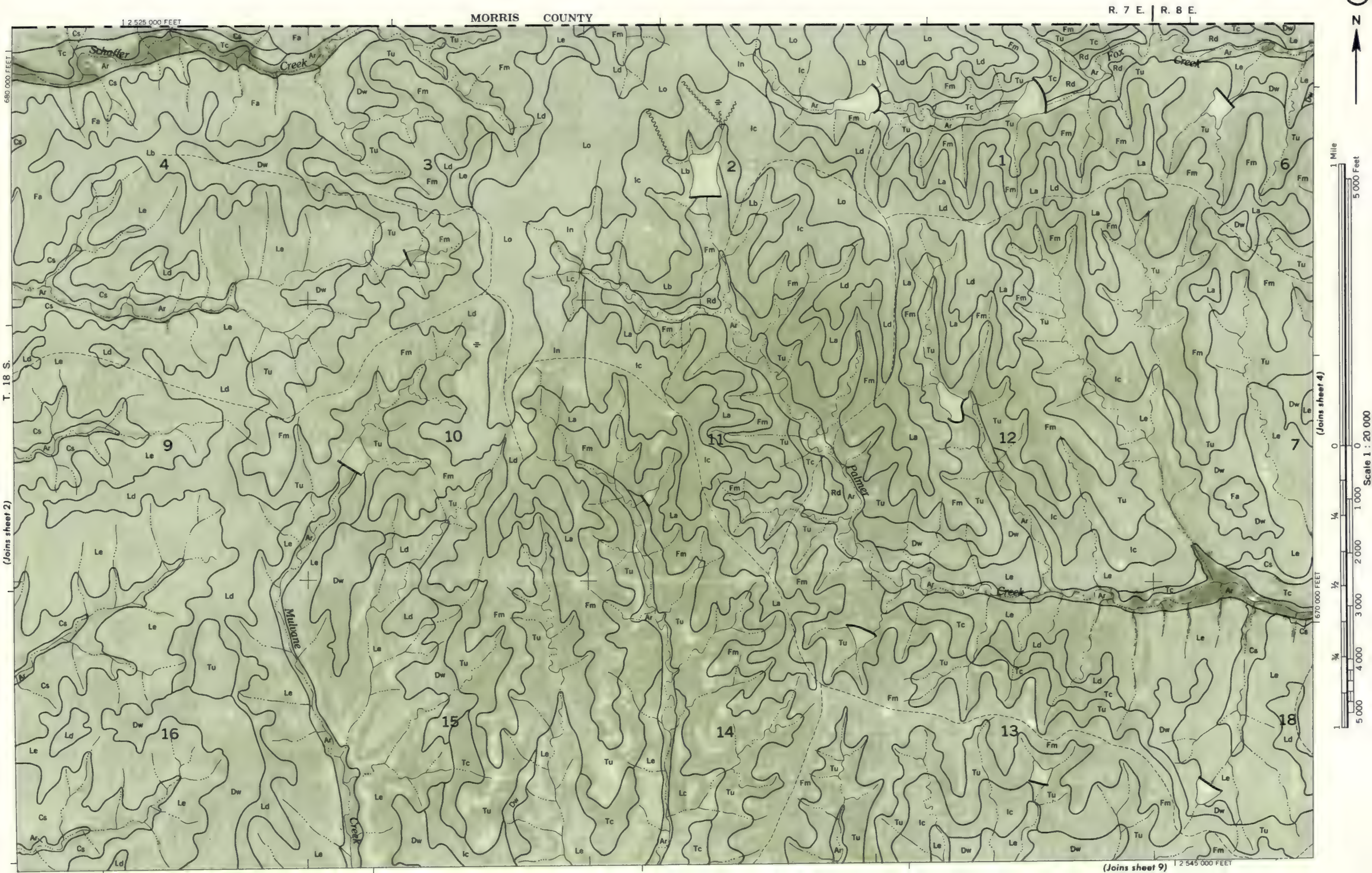

N
(Joins sheet 20)
R. 6 E. | R. 7 E.
2 520 000 FEET
615 000 FEET
T. 20 S.
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 32)
2 505 000 FEET
605 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000
Gould Creek
Silver Creek
COTTONWOOD RIVER
ATCHISON TOPEKA AND SANTA FE
Holmes Creek
Clements School
50

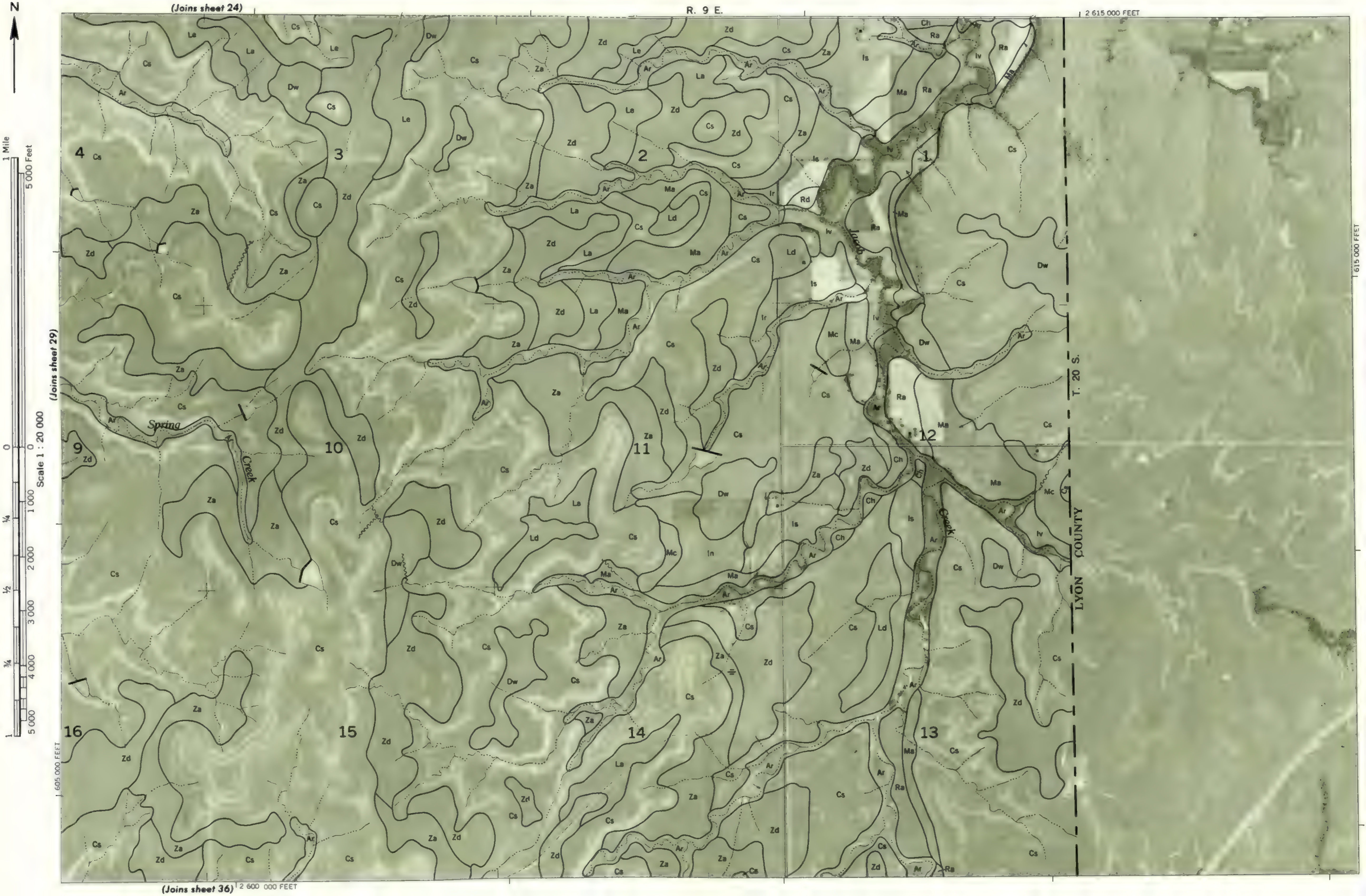


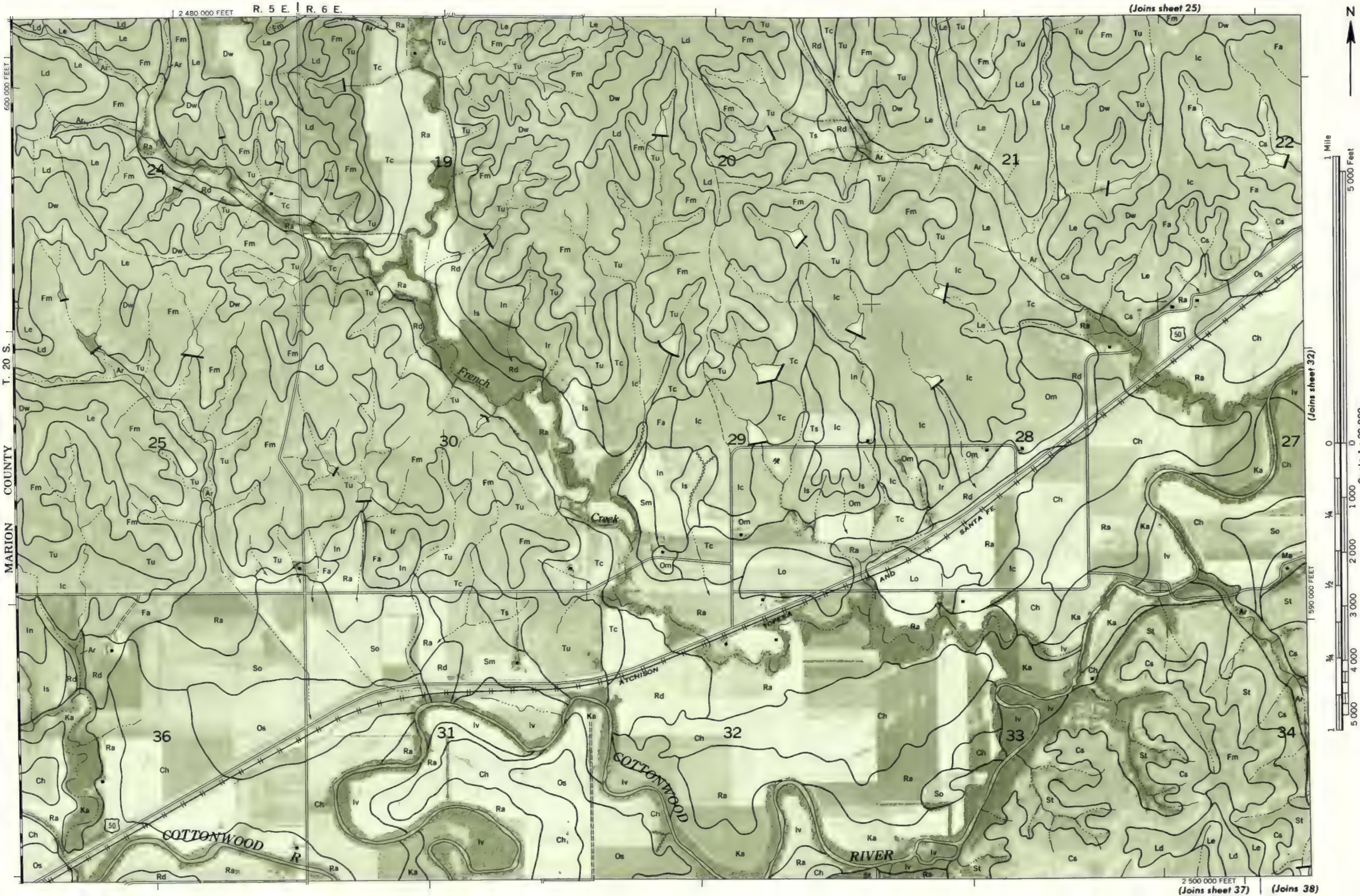
27
N
R. 7 E.
R. 8 E.
(Joins sheet 21)
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 33)
T. 20 S.
2 525 000 FEET
615 000 FEET
605 000 FEET
2 545 000 FEET
COTTONWOOD
RIVER
CAMP WOOD
Camp Wood Lake
Prather Creek
Spring Creek
Buckeye Creek
1 Mile
5 000 Feet
Scale 1 : 20 000


N
(Joins sheet 22)
R. 8 E.
2 570 000 FEET
615 000 FEET
(Joins sheet 27)
T. 20 S.
(Joins sheet 29)
605 000 FEET
2 550 000 FEET
(Joins sheet 34)
1 Mile
5 000 Feet
Scale 1 : 20 000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Spring Creek
Buckeye Creek
Cottonwood
S. Fork
Atchison Topeka and Santa Fe
177
3
4
5
6
7
8
9
10
15
16
17
18

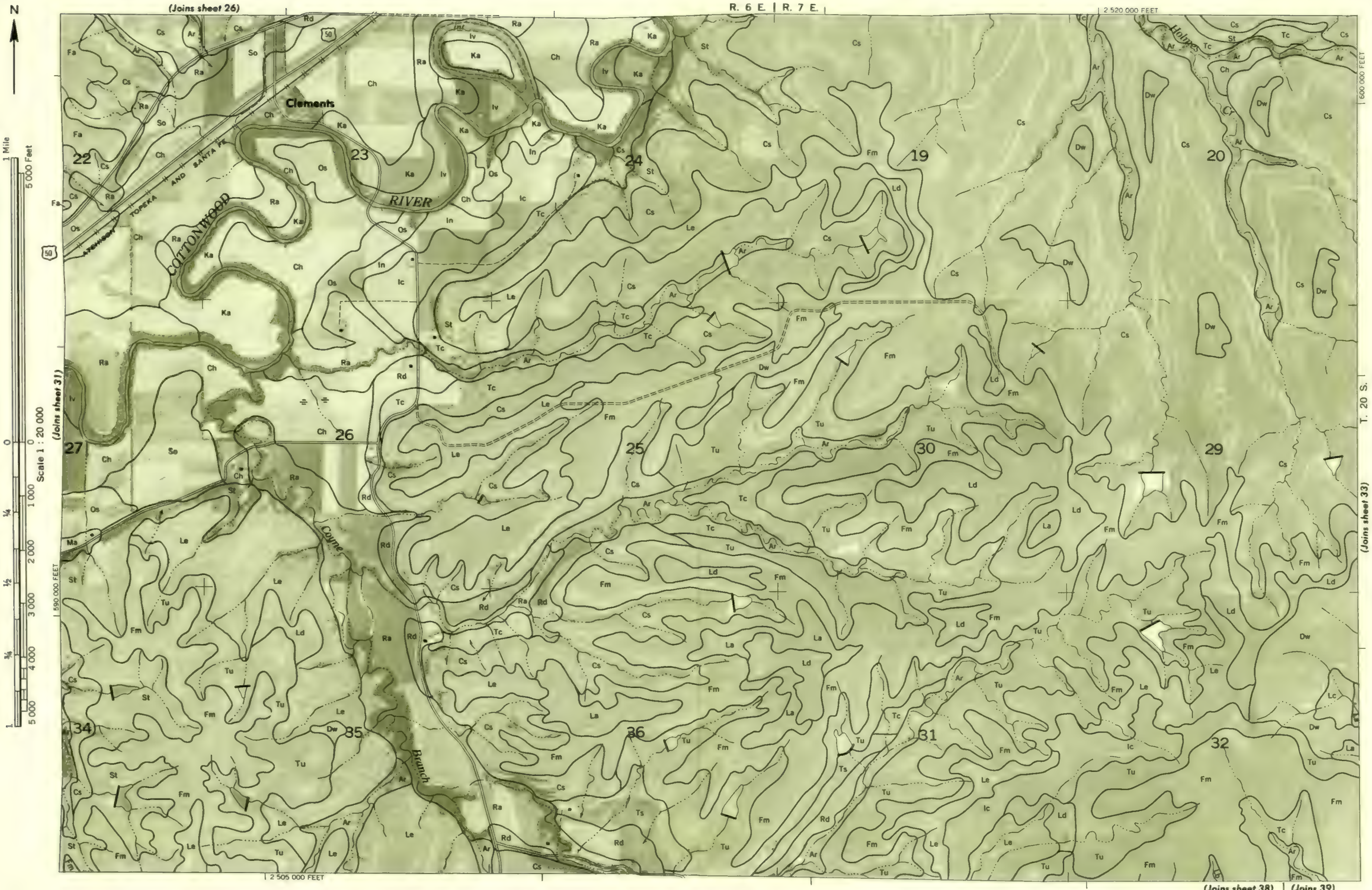

29
N
R. 8 E. | R. 9 E.
2 575 000 FEET
(Joins sheet 23)
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 35)
2 595 000 FEET
615 000 FEET
605 000 FEET
T. 20 S.
Gladstone
ATCHISON TOPEKA AND SANTA FE
RIVER
COTTONWOOD
SOUTH
FORK
Bloody
Creek
Spring
Creek
1 Mile
5 000 Feet
Scale 1 : 20 000
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18
Ar
Ch
Cs
Dw
Ic
In
Ir
Is
Iv
Ka
Le
Lo
Ls
Ma
Mc
Om
Os
Ra
Rd
Re
St
Tc
Za
Zd

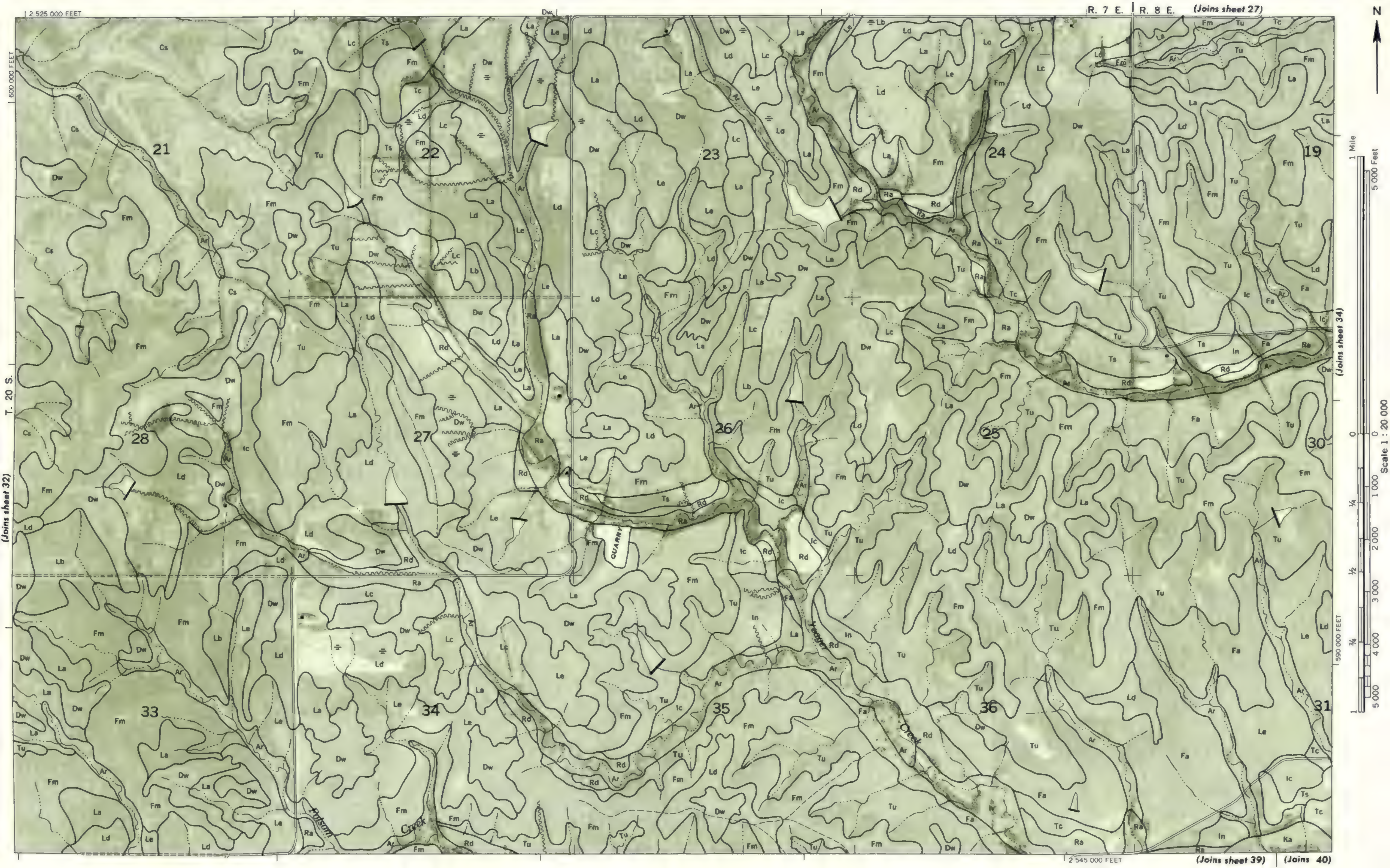

MORRIS COUNTY
R. 7 E. | R. 8 E.
N
1 2 525 000 FEET
680 000 FEET
T. 18 S.
Schaffer Creek
Fox Creek
Palmer Creek
Mulvane Creek
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 9)
670 000 FEET
2 545 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000

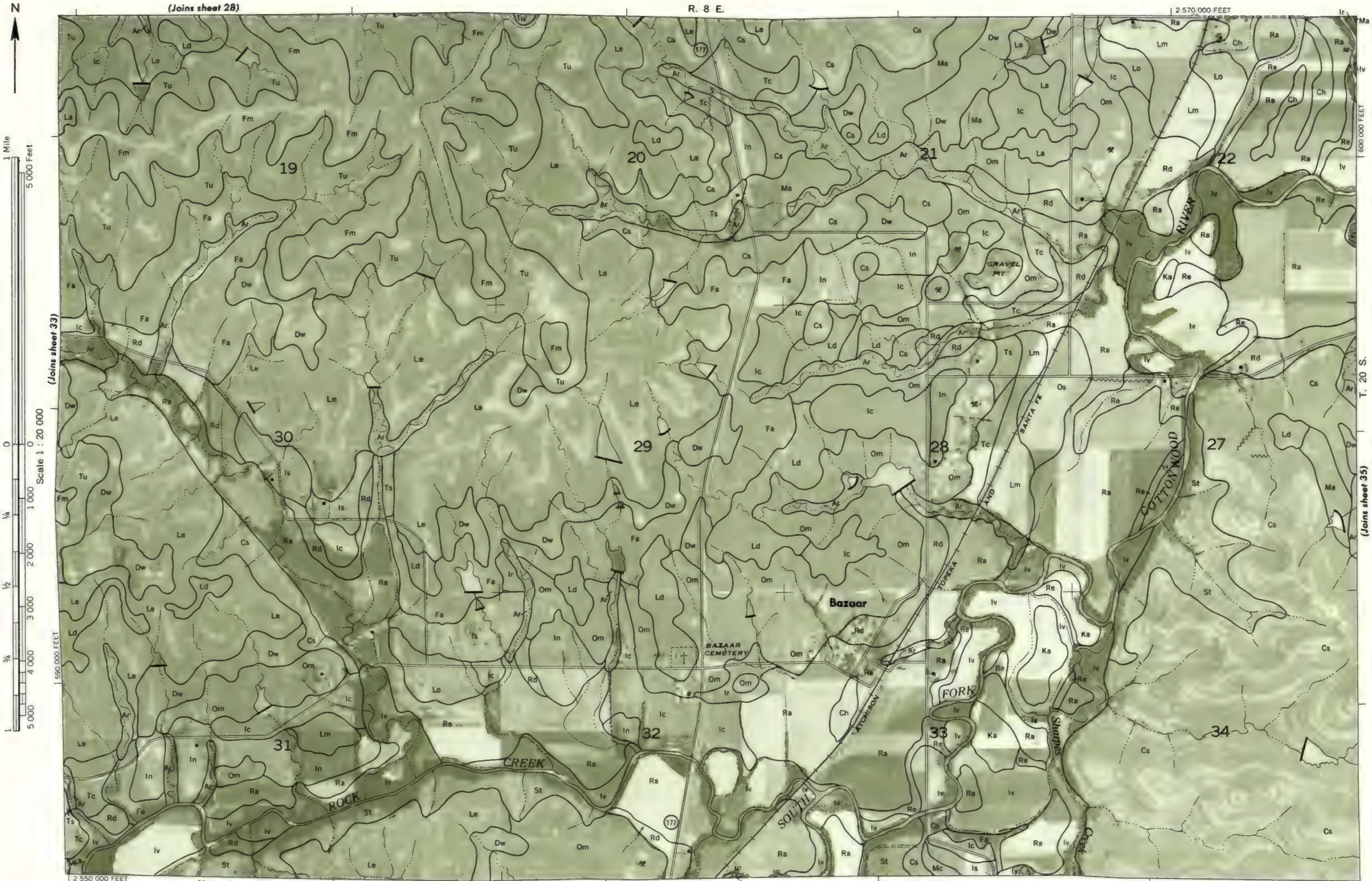

N
(Joins sheet 24)
R. 9 E.
2 615 000 FEET
615 000 FEET
(Joins sheet 29)
T. 20 S.
LYON COUNTY
(Joins sheet 36)
2 600 000 FEET
605 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000
Spring
Creek
Jacob
Creek

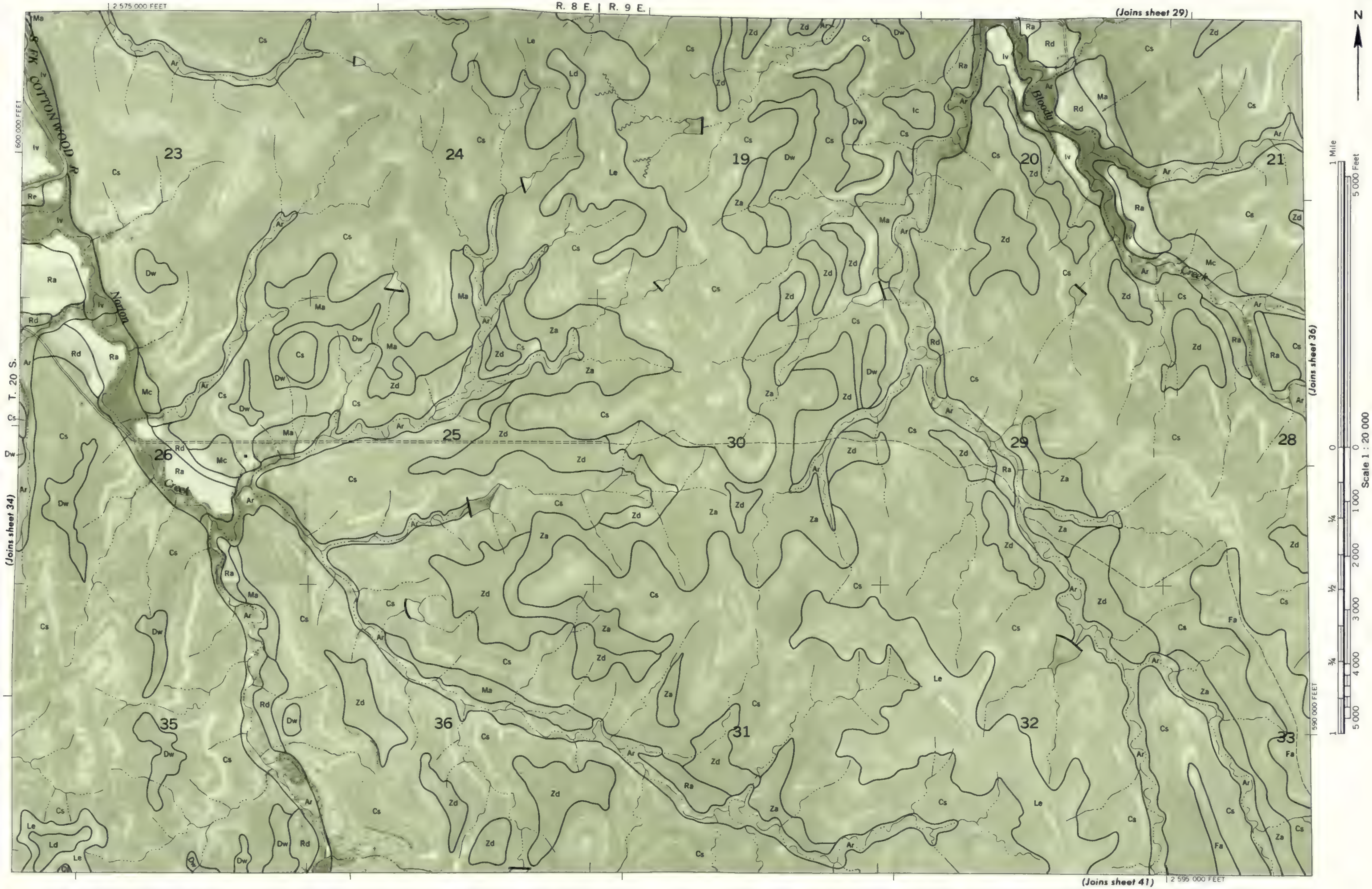


2 480 000 FEET
R. 5 E.
R. 6 E.
(Joins sheet 25)
N
600 000 FEET
T. 20 S.
MARION COUNTY
(Joins sheet 32)
590 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000
French
Creek
COTTONWOOD
COTTONWOOD R
RIVER
ATCHISON
TOPEKA
AND
SANTA FE
50
2 500 000 FEET
(Joins sheet 37)
(Joins 38)

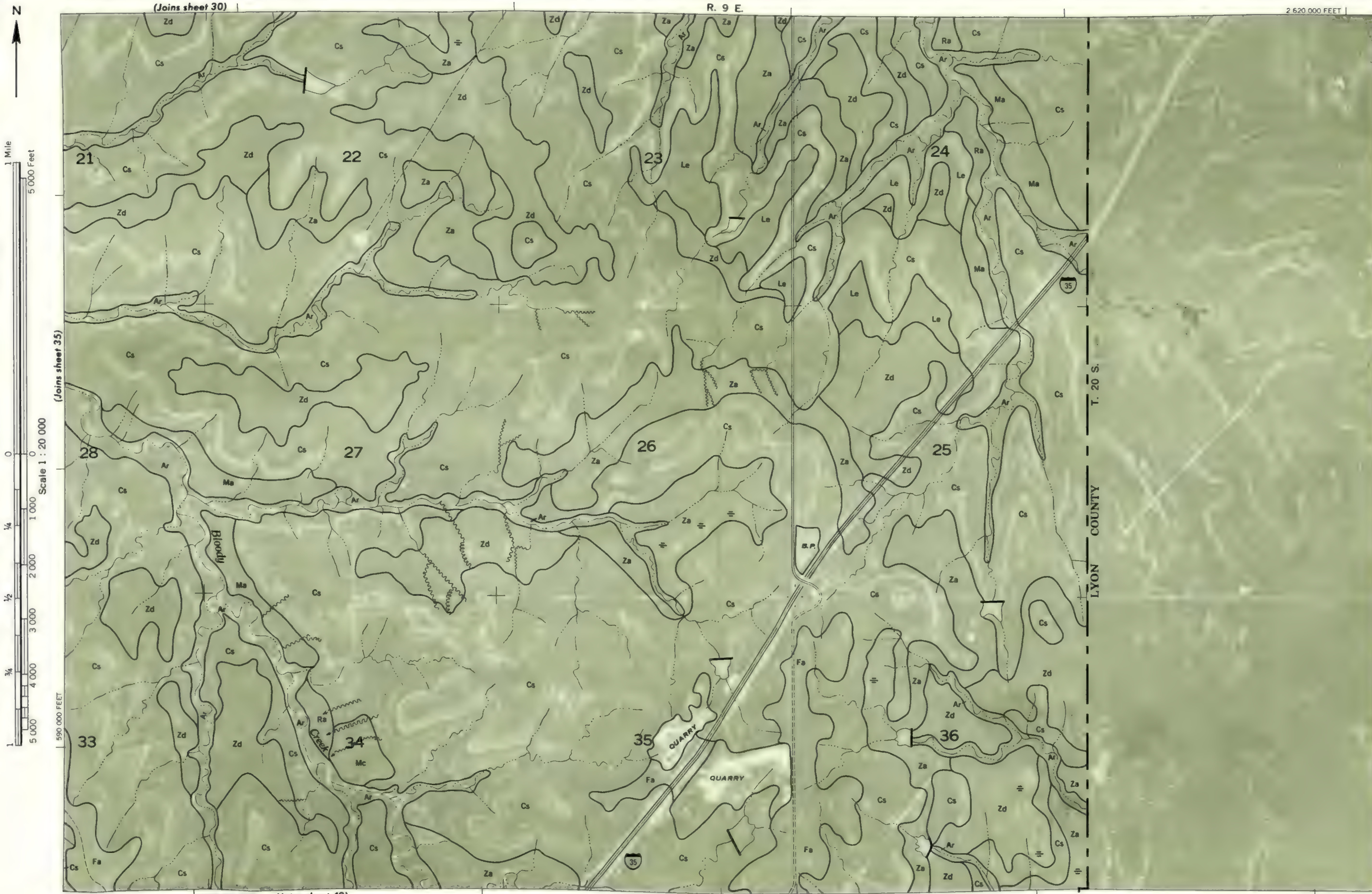

(Joins sheet 26)
R. 6 E. | R. 7 E.
2 520 000 FEET
600 000 FEET
N
1 Mile
5 000 Feet
Scale 1: 20 000
0
1/4
1/2
3/4
1
0
1 000
2 000
3 000
4 000
5 000
(Joins sheet 31)
590 000 FEET
Clements
COTTONWOOD
RIVER
ATCHISON TOPEKA AND SANTA FE
50
Holmes
Cr.
Coyne
Branch
T. 20 S.
(Joins sheet 33)
2 505 000 FEET
(Joins sheet 38)
(Joins 39)
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36


2 525 000 FEET
600 000 FEET
R. 7 E.
R. 8 E.
(Joins sheet 27)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 39)
(Joins 40)
T. 20 S.
N
1 Mile
5 000 Feet
Scale 1 : 20 000
590 000 FEET
2 545 000 FEET
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
QUARRY
Folsom
Creek
Yeager
Creek


N
(Joins sheet 28)
R. 8 E.
2 570 000 FEET
600 000 FEET
T. 20 S.
(Joins sheet 35)
(Joins sheet 33)
(Joins sheet 40)
2 550 000 FEET
590 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000
19
20
21
22
27
28
29
30
31
32
33
34
Bazaar
BAZAAR CEMETERY
GRAVEL PIT
COTTONWOOD
RIVER
SOUTH
FORK
ROCK
CREEK
Sharpes
Creek
ATCHISON
TOPEKA
AND
SANTA FE


N
2 575 000 FEET
R. 8 E. | R. 9 E.
(Joins sheet 29)
(Joins sheet 36)
(Joins sheet 34)
(Joins sheet 41)
2 595 000 FEET
600 000 FEET
590 000 FEET
T. 20 S.
S FK COTTONWOOD R
Norton
Creek
Bloody
Creek
1 Mile
5 000 Feet
Scale 1 : 20 000
0
¼
½
¾
1
0
1 000
2 000
3 000
4 000
5 000
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Ar
Cs
Dw
Fa
Ic
Iv
Ld
Le
Ma
Mc
Ra
Rd
Re
Za
Zd

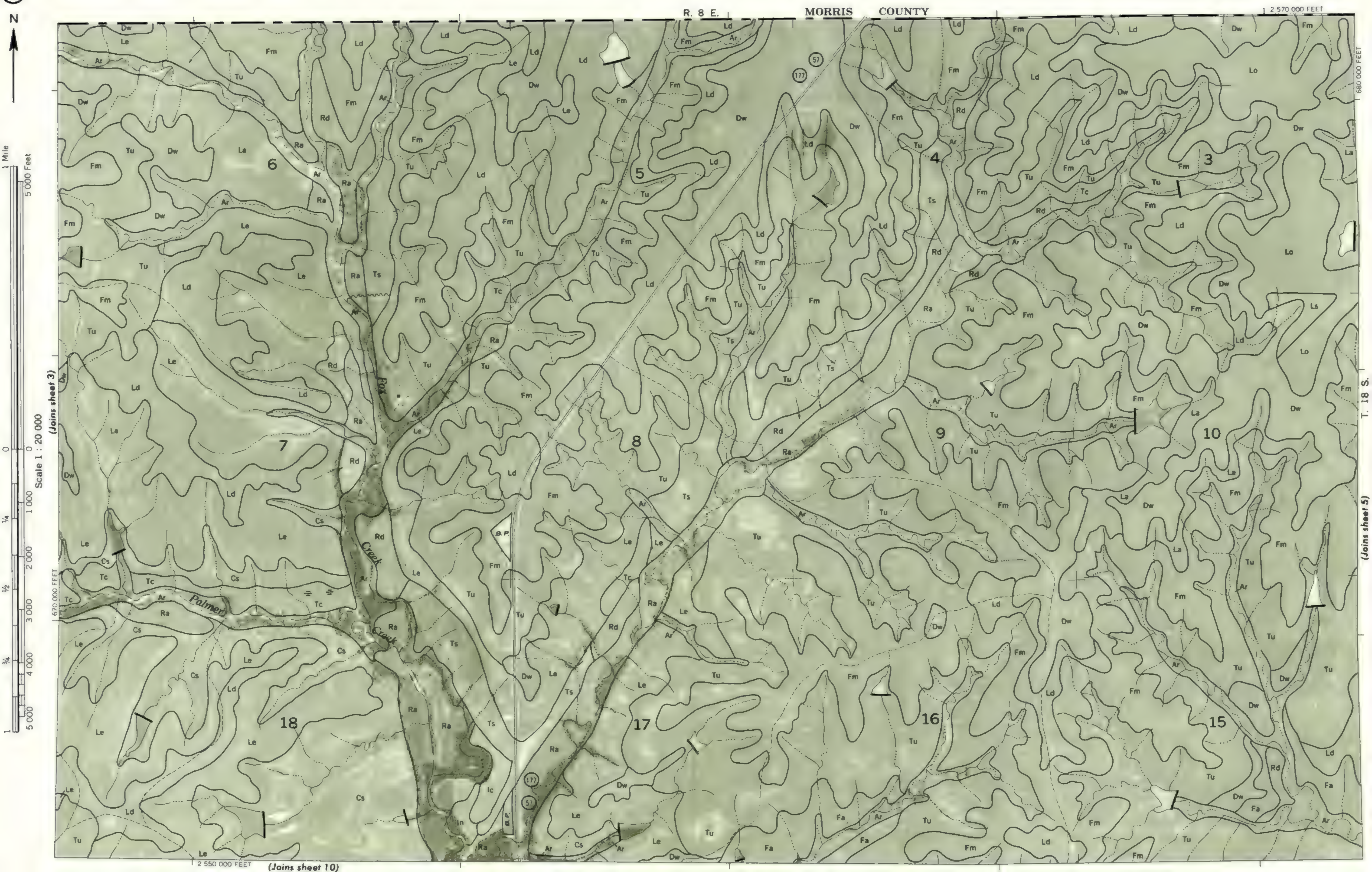
CHASE COUNTY, KANSAS — SHEET NUMBER 36

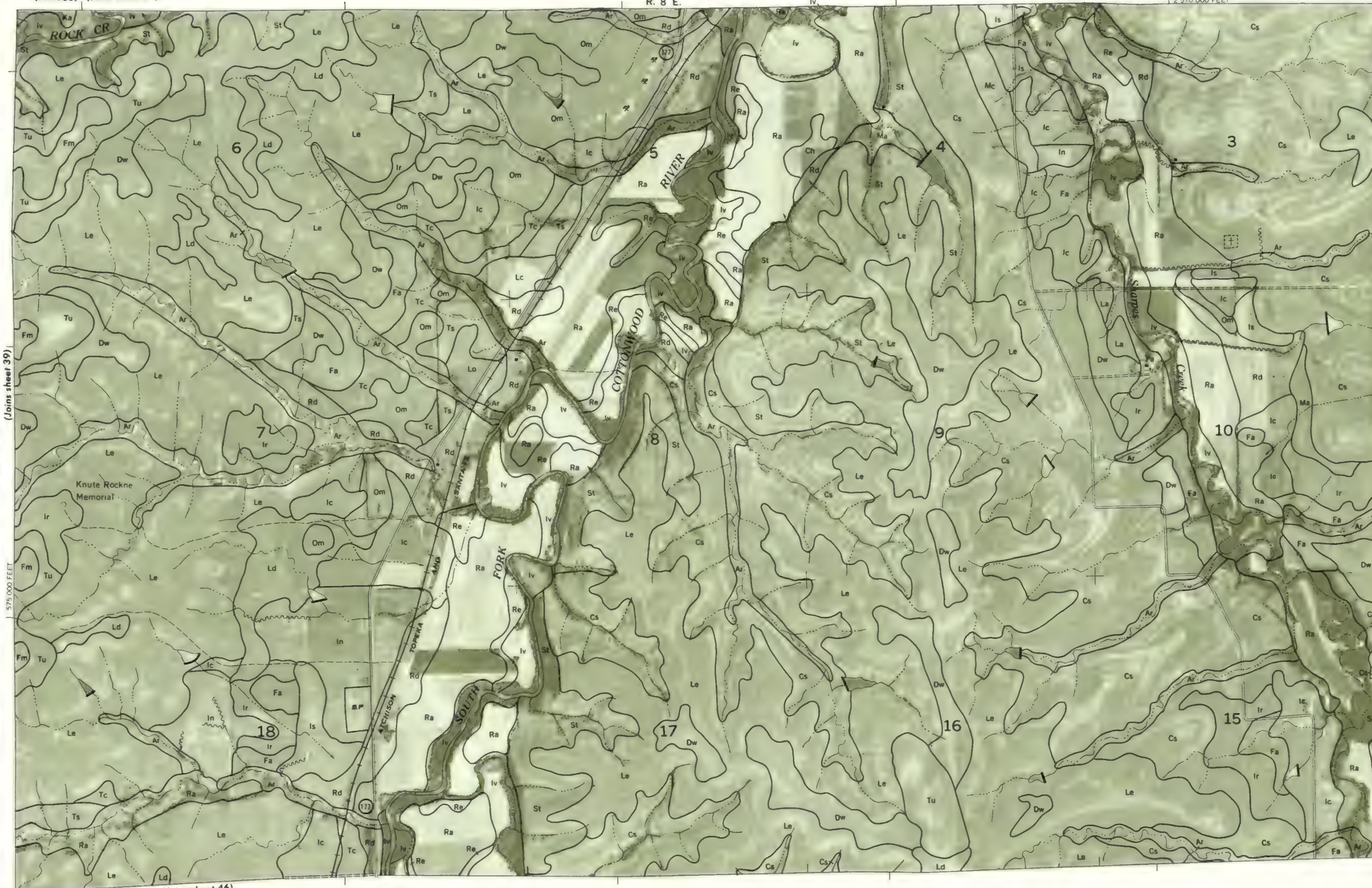


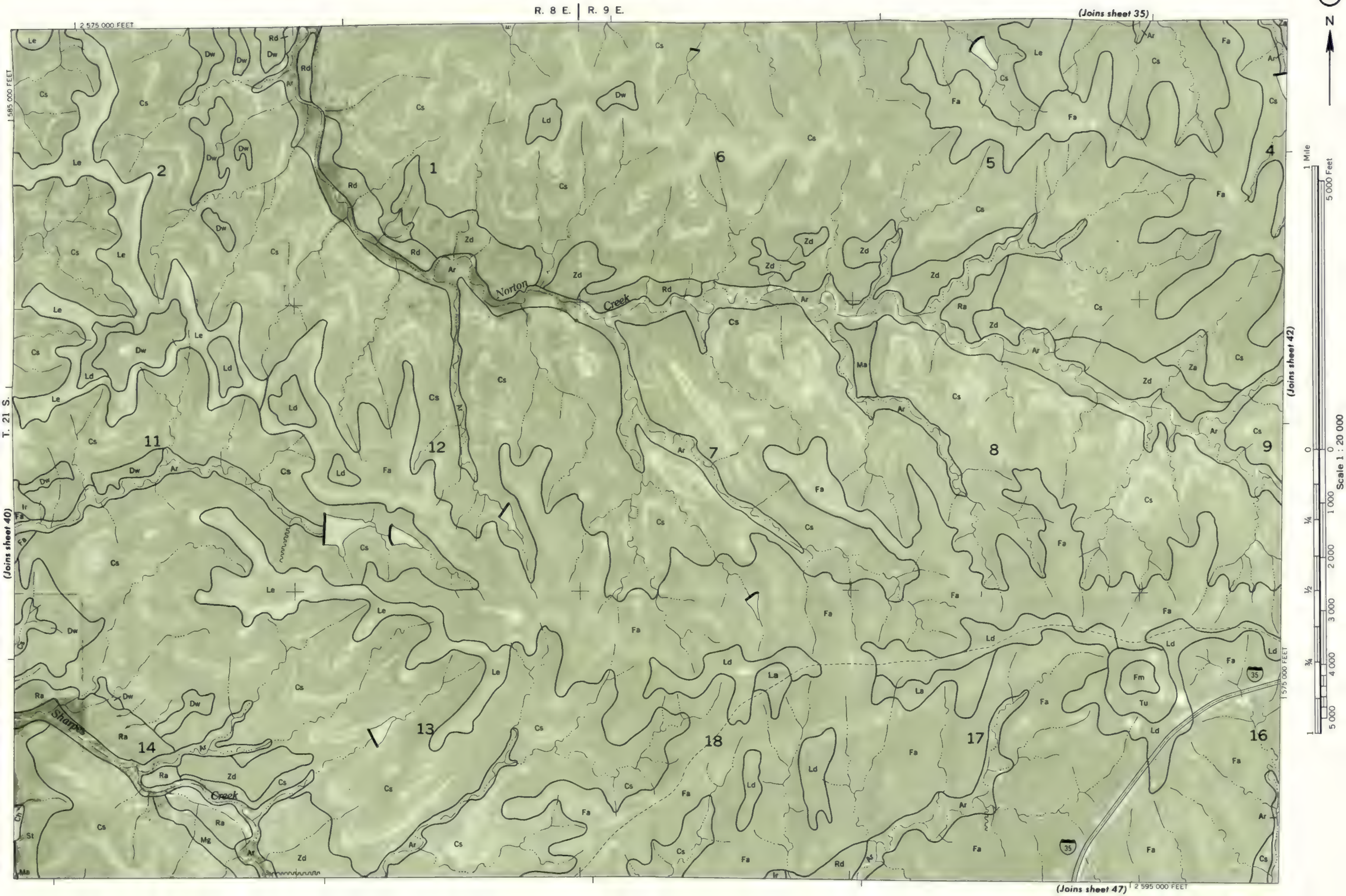

37
N
(Joins sheet 31)
(Joins sheet 38)
(Joins sheet 43)
1 2 480 000 FEET
R. 5 E.
R. 6 E.
2 500 000 FEET
580 000 FEET
570 000 FEET
T. 21 S.
MARION COUNTY
50
A T AND S F
Cedar Point
COTTONWOOD RIVER
COTTONWOOD R
CEDAR CREEK
Little Turkey Creek
Coon Creek
CEDAR POINT CEMETERY
1 Mile
5 000 Feet
Scale 1 : 20 000
0
1/4
1/2
3/4
1
0
1 000
2 000
3 000
4 000
5 000


N
(Joins 31)
(Joins sheet 32)
R. 6 E. | R. 7 E.
2 520 000 FEET
585 000 FEET
T. 21 S.
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 44)
2 505 000 FEET
570 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000
Coyne
Branch
Little
Turkey
Creek


(Joins 32) | (Joins sheet 33)
2 525 000 FEET
R. 7 E | R. 8 E
N
585 000 FEET
T. 21 S.
Land division corners are approximately positioned on this map
(Joins sheet 38)
(Joins sheet 40)
575 000 FEET
2 545 000 FEET
(Joins sheet 45)
Folsom
Creek
Rock
Creek
Yeager
Cr.
Birley
1 Mile
5 000 Feet
Scale 1 : 20 000

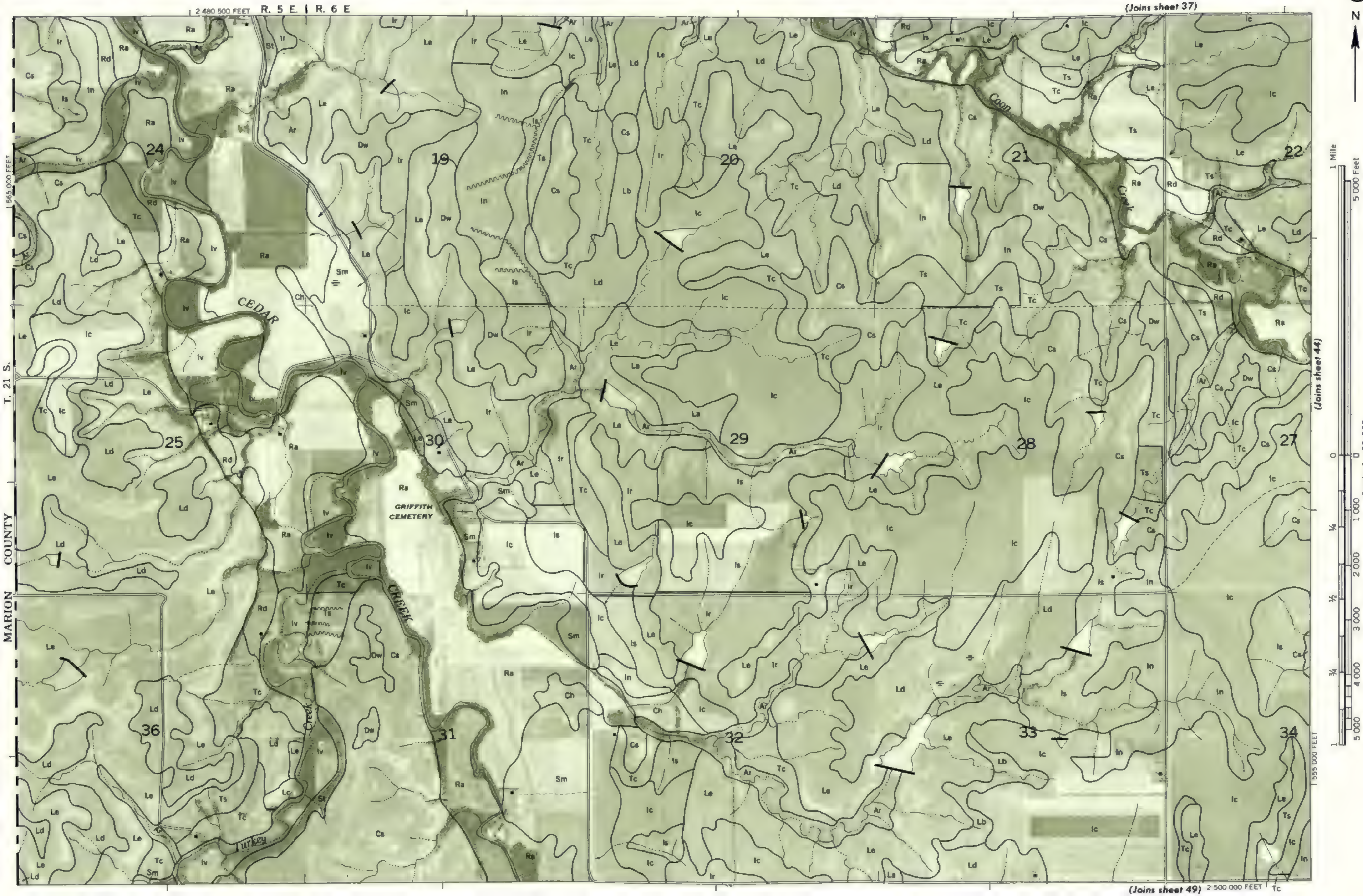

N
1 Mile
5 000 Feet
Scale 1 : 20 000
R. 8 E.
MORRIS COUNTY
2 570 000 FEET
680 000 FEET
T. 18 S.
(Joins sheet 5)
(Joins sheet 3)
(Joins sheet 10)
2 550 000 FEET
670 000 FEET
Fox Creek
Palmer Creek
3
4
5
6
7
8
9
10
15
16
17
18
57
177


(Joins 33)
(Joins sheet 34)
R. 8 E.
2 570 000 FEET
585 000 FEET
T. 21 S.
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 46)
2 550 000 FEET
575 000 FEET
N
1 Mile
5 000 Feet
Scale 1 : 20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000
ROCK CR
COTTONWOOD
RIVER
SOUTH
FORK
Sharps
Creek
ATCHISON TOPEKA AND SANTA FE
Knute Rockne
Memorial
177
3
4
5
6
7
8
9
10
15
16
17
18

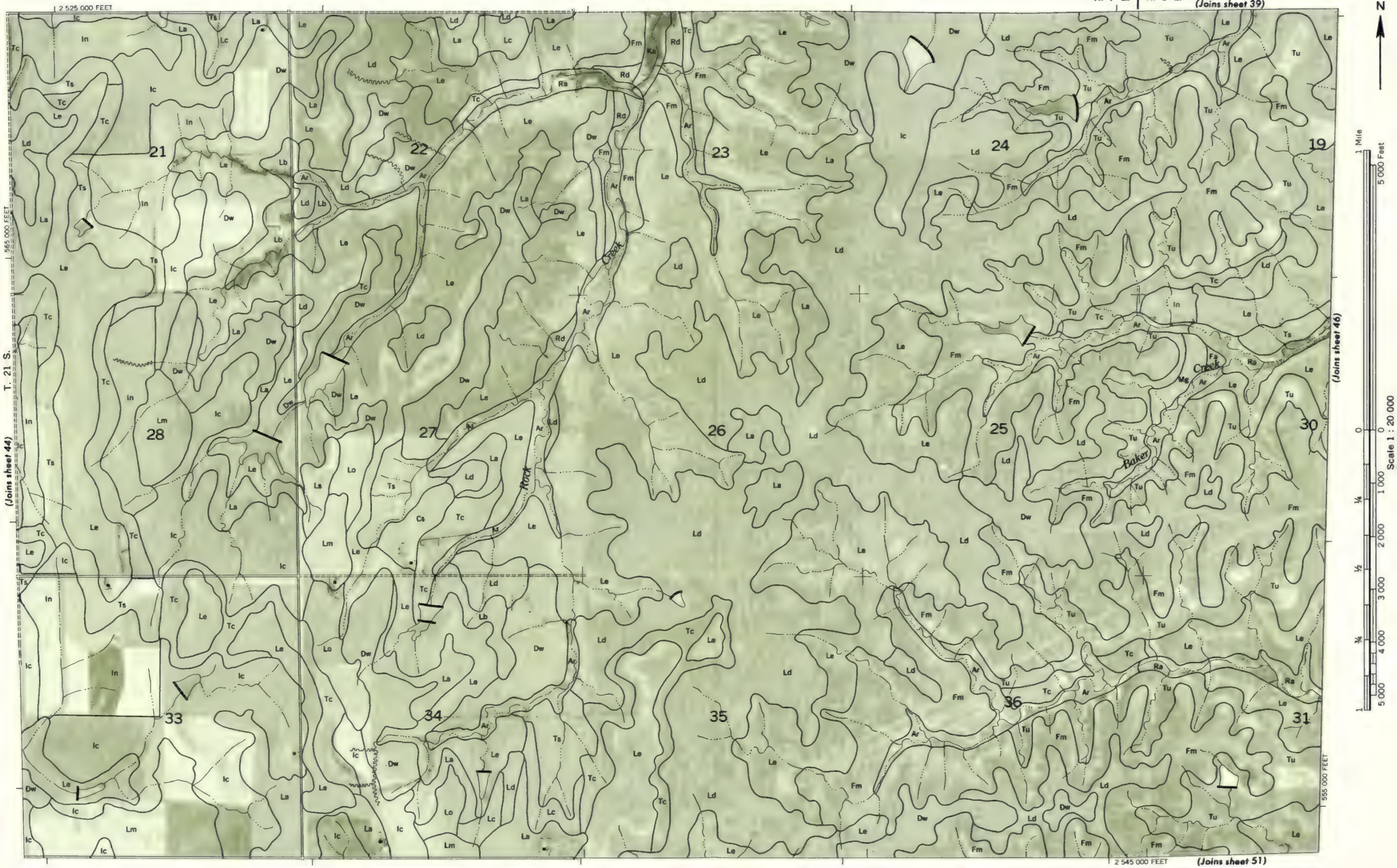

R. 8 E.
R. 9 E.
(Joins sheet 35)
(Joins sheet 42)
(Joins sheet 47)
(Joins sheet 40)
T. 21 S.
2 575 000 FEET
585 000 FEET
575 000 FEET
2 595 000 FEET
N
Norton Creek
Sharps Creek
35
1 Mile
5 000 Feet
Scale 1 : 20 000


42
N
(Joins sheet 36)
R. 9 E.
2 620 000 FEET
585 000 FEET
575 000 FEET
2 600 000 FEET
(Joins sheet 41)
(Joins sheet 48)
T. 21 S.
LYON COUNTY
Bloody Creek
Faun Creek
Camp Creek
35
1 Mile
5 000 Feet
Scale 1 : 20 000
0
¼
½
¾
1
1000
2000
3000
4000
5000
1
2
3
4
9
10
11
12
13
14
15
16
Cs
Fa
Za
Zd
Ar
Ld
Mg

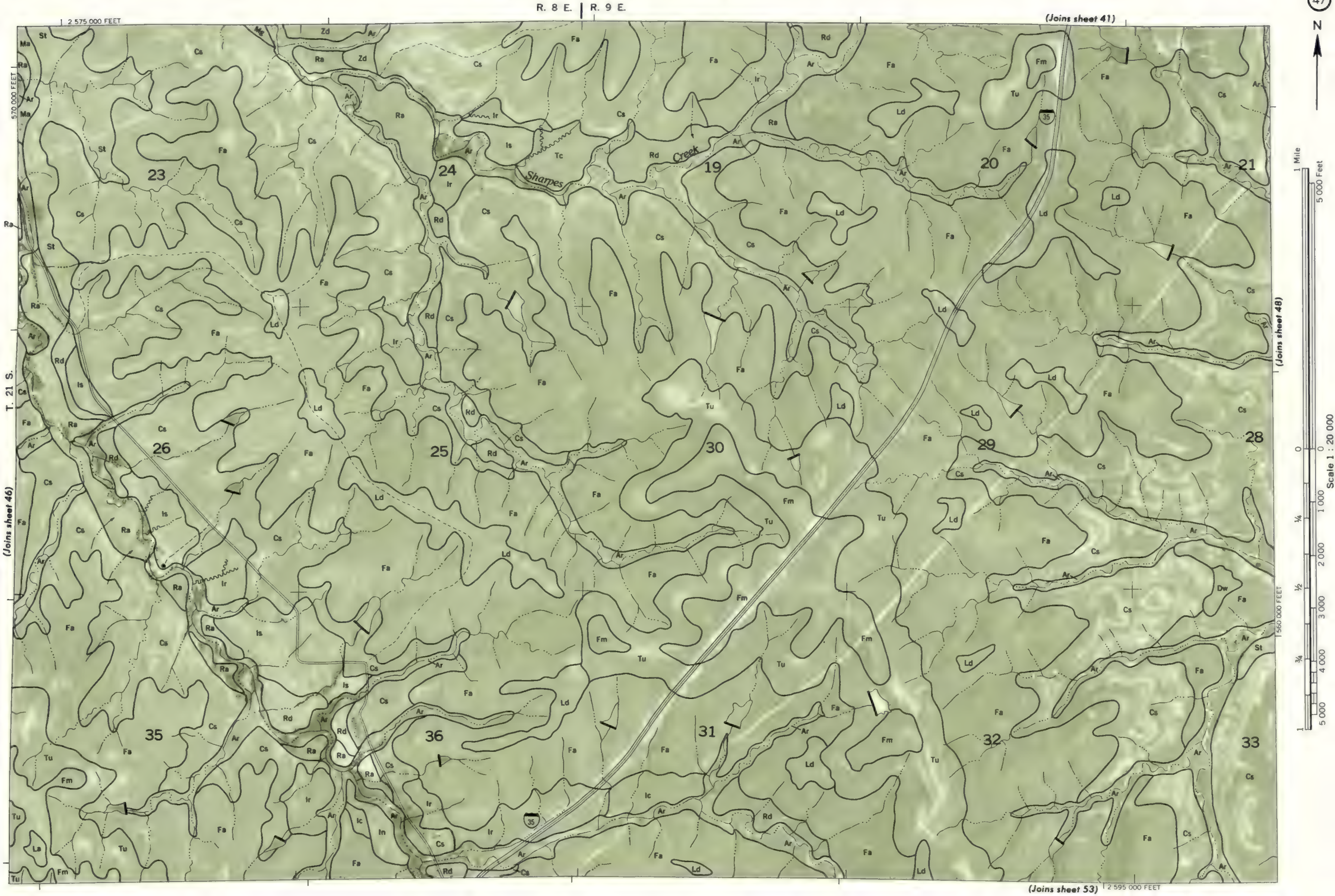
CHASE COUNTY, KANSAS — SHEET NUMBER 43



CHASE COUNTY, KANSAS — SHEET NUMBER 44


45
R. 7 E. | R. 8 E.
(Joins sheet 39)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 51)
2 525 000 FEET
2 545 000 FEET
555 000 FEET
T. 21 S.
N
Rock
Creek
Baker
Creek
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
1 Mile
5 000 Feet
Scale 1 : 20 000

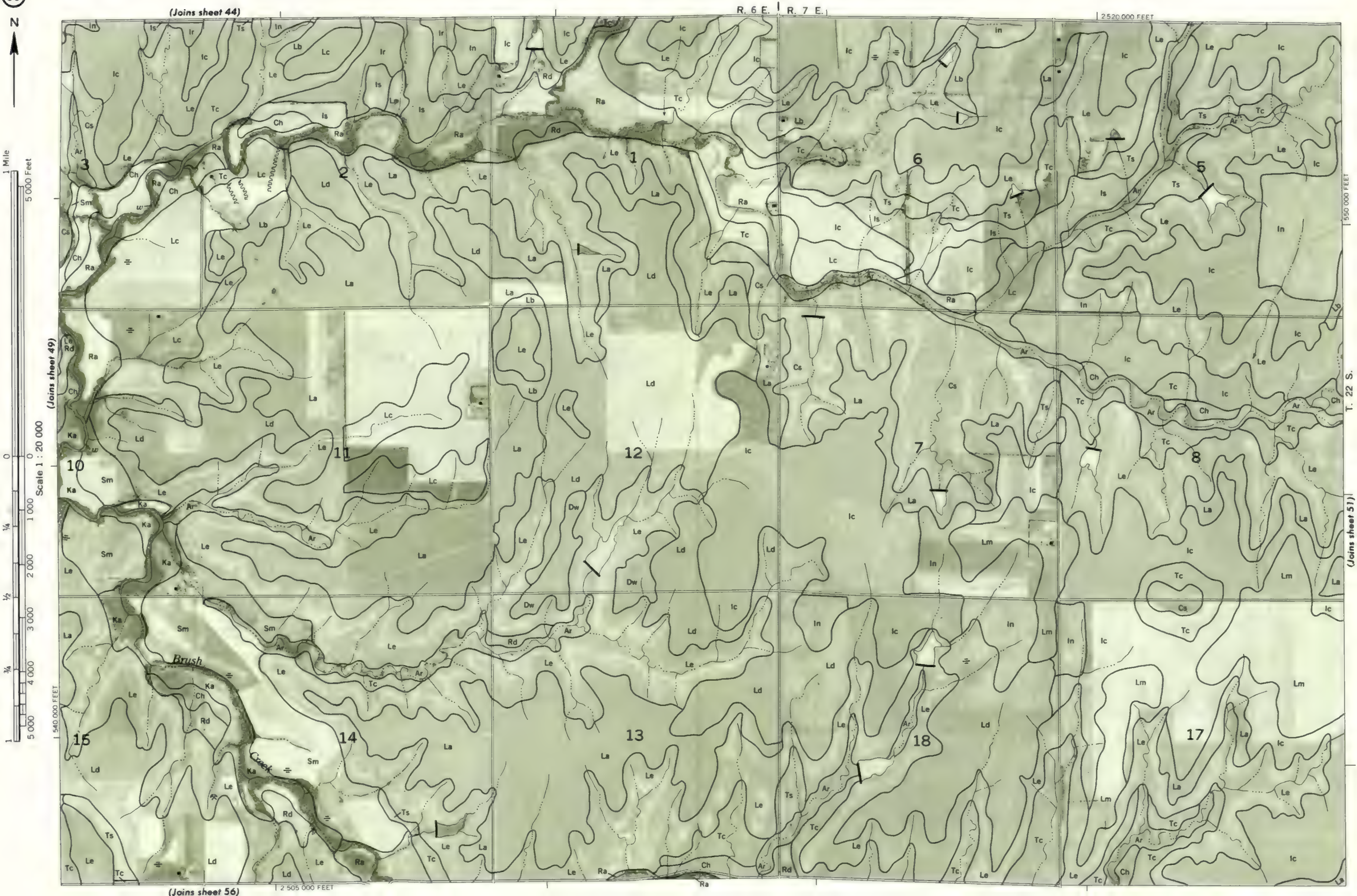
CHASE COUNTY, KANSAS — SHEET NUMBER 46

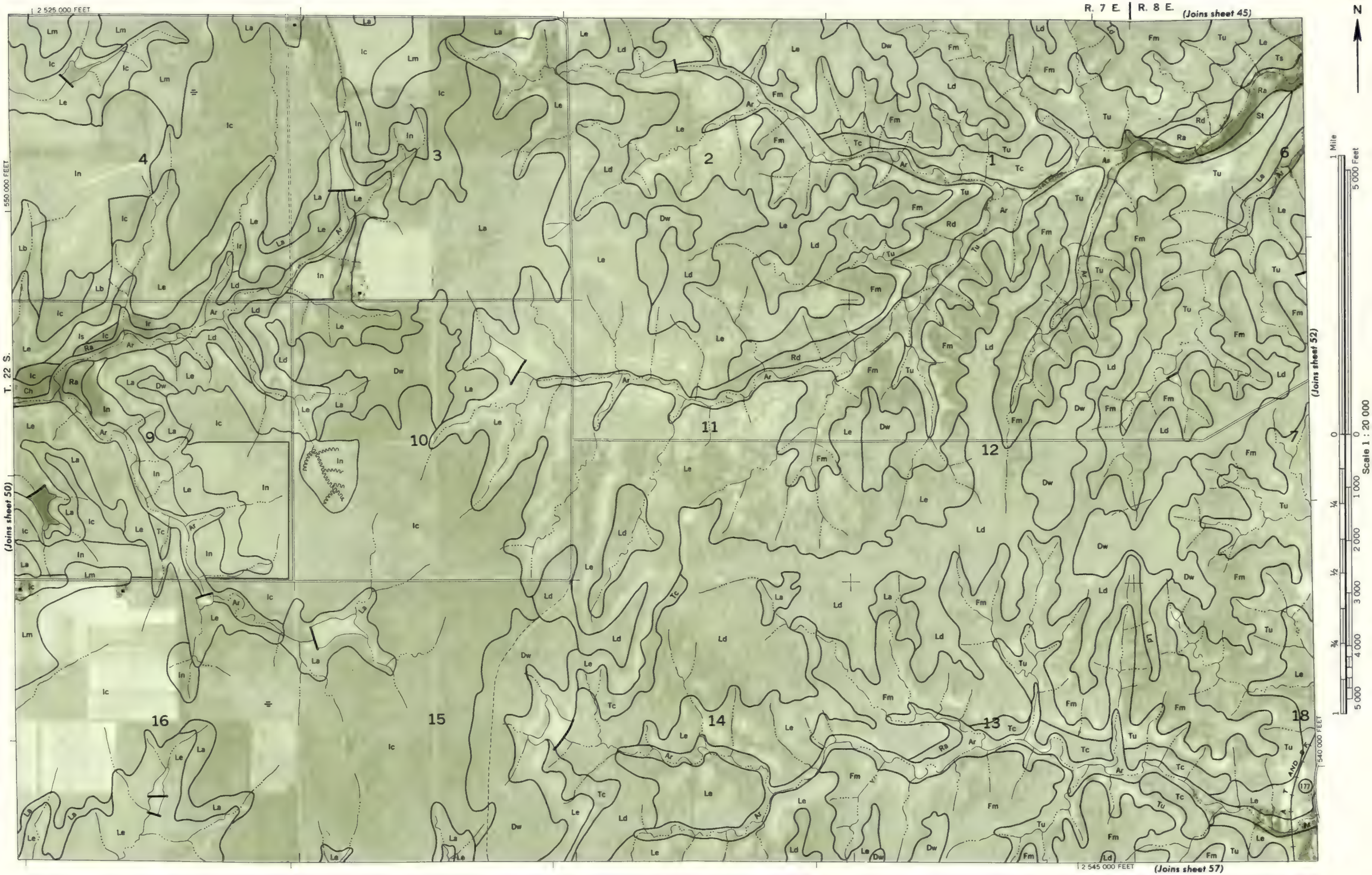

R. 8 E.
R. 9 E.
2 575 000 FEET
570 000 FEET
560 000 FEET
2 595 000 FEET
(Joins sheet 41)
(Joins sheet 48)
(Joins sheet 46)
(Joins sheet 53)
T. 21 S.
N
Sharpes
Creek
35
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 Mile
5 000 Feet
Scale 1 : 20 000
0
1/4
1/2
3/4
1 000
2 000
3 000
4 000
5 000


(Joins sheet 42)
R. 9 E.
2 620 000 FEET
570 000 FEET
N
1 Mile
5 000 Feet
Scale 1 : 20 000
(Joins sheet 47)
550 000 FEET
T. 21 S.
2 600 000 FEET
(Joins sheet 54)
Camp Creek
VERDIGRIS RIVER
Verdigris River
LYON COUNTY

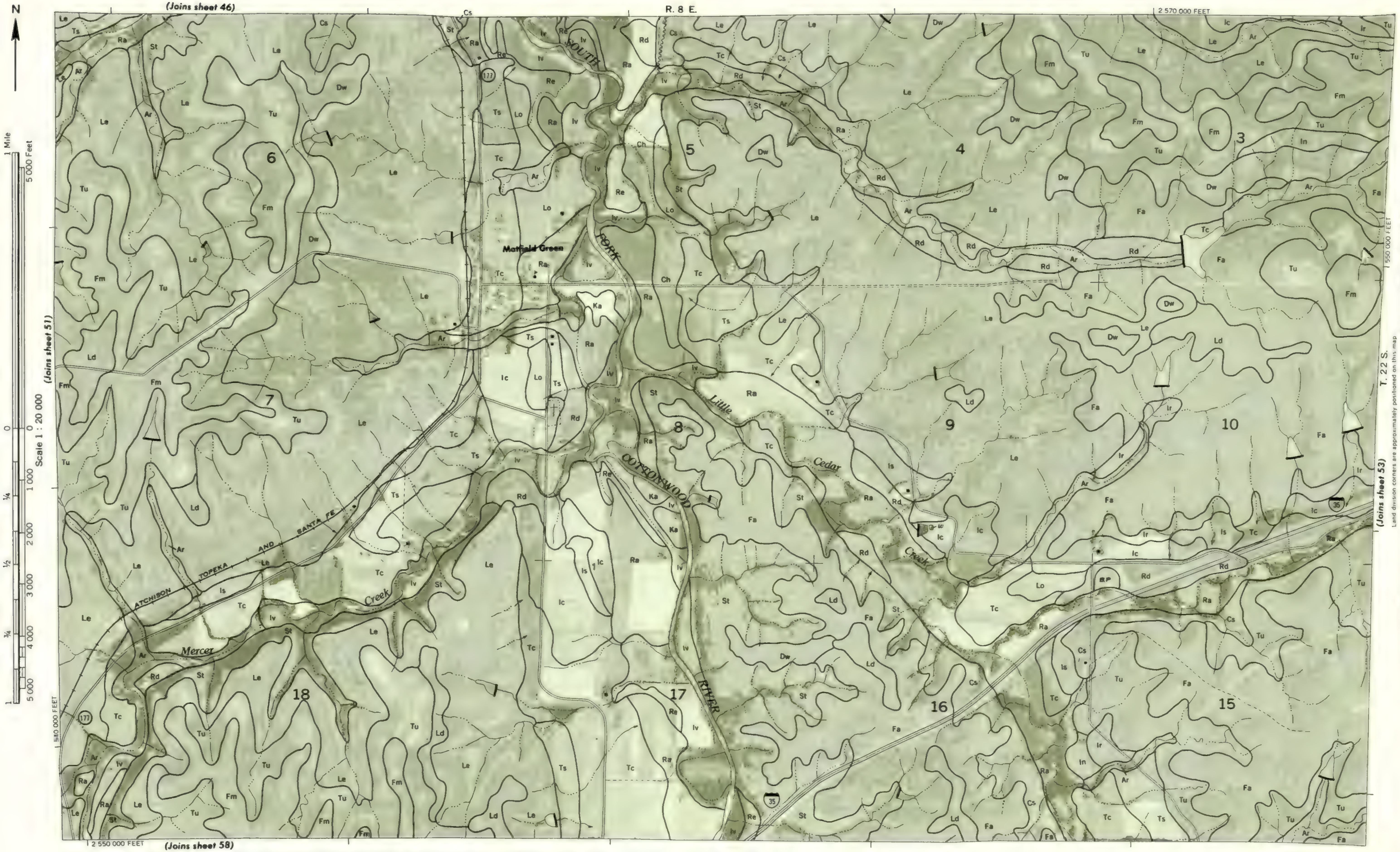

2 480 000 FEET
R. 5 E. | R. 6 E.
(Joins sheet 43)
N
550 000 FEET
T. 22 S.
MARION COUNTY
CEDAR CREEK
Turkey Creek
Middle Creek
BRUSH CREEK
Bills Creek
WONSEVU CEMETERY
Wonsevu
(Joins sheet 50)
(Joins sheet 55)
2 500 000 FEET
540 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000


2 575 000 FEET
R. 8 E. | R. 9 E.
MORRIS COUNTY
Lake Kahola
Indian Creek
Buckeye Creek
Peyton Creek
680 000 FEET
T. 18 S.
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 11)
670 000 FEET
2 595 000 FEET
N
1 Mile
5 000 Feet
Scale 1 : 20 000


(Joins sheet 44)
(Joins sheet 49)
(Joins sheet 51)
(Joins sheet 56)
R. 6 E.
R. 7 E.
T. 22 S.
N
1 Mile
5 000 Feet
Scale 1:20 000
2 520 000 FEET
550 000 FEET
540 000 FEET
2 505 000 FEET
Brush Creek



2 525 000 FEET
R. 7 E.
R. 8 E.
(Joins sheet 45)
550 000 FEET
T. 22 S.
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 57)
2 545 000 FEET
540 000 FEET
N
1 Mile
5000 Feet
Scale 1 : 20 000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
177



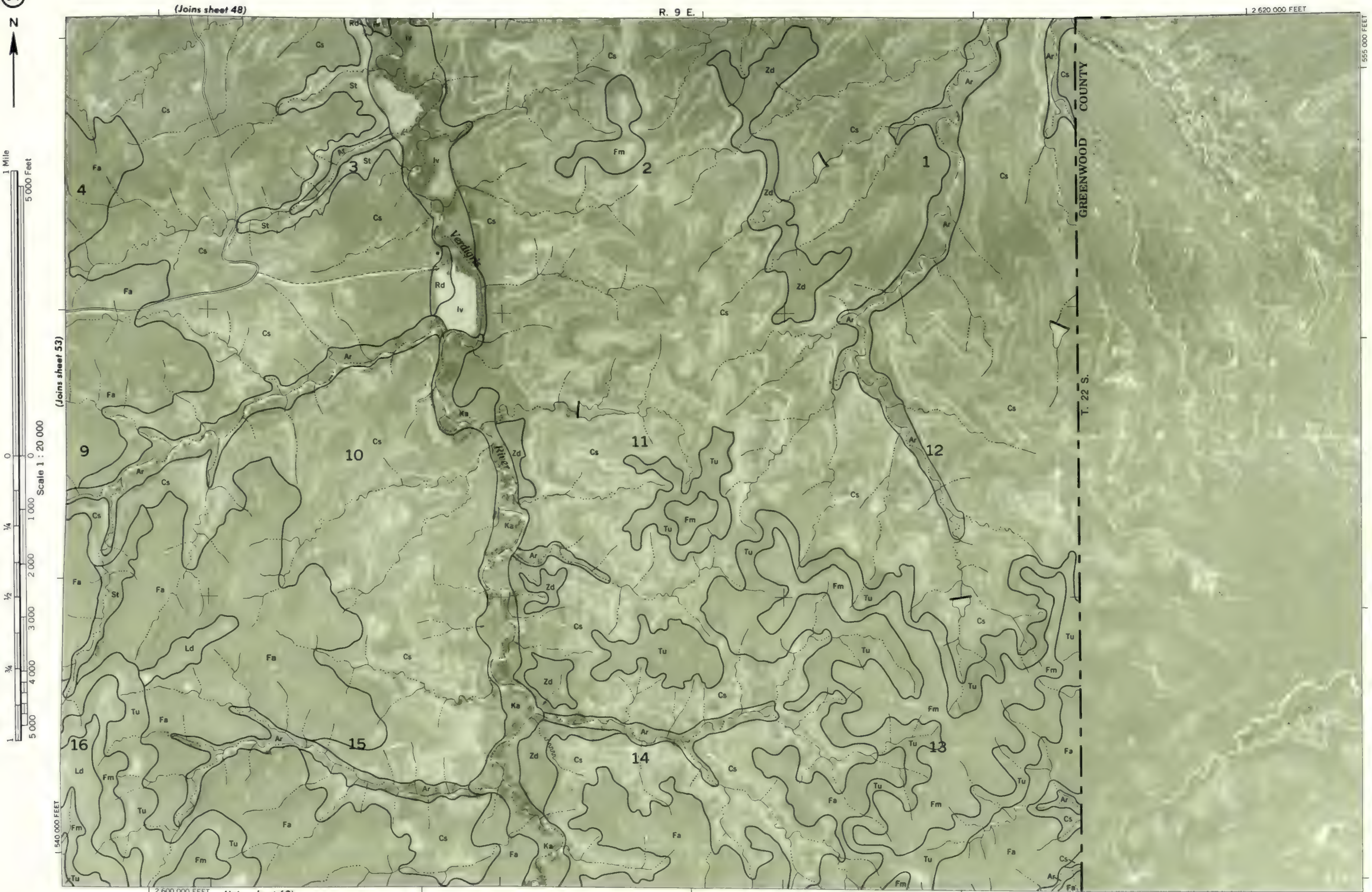
Land division corners are approximately positioned on this map

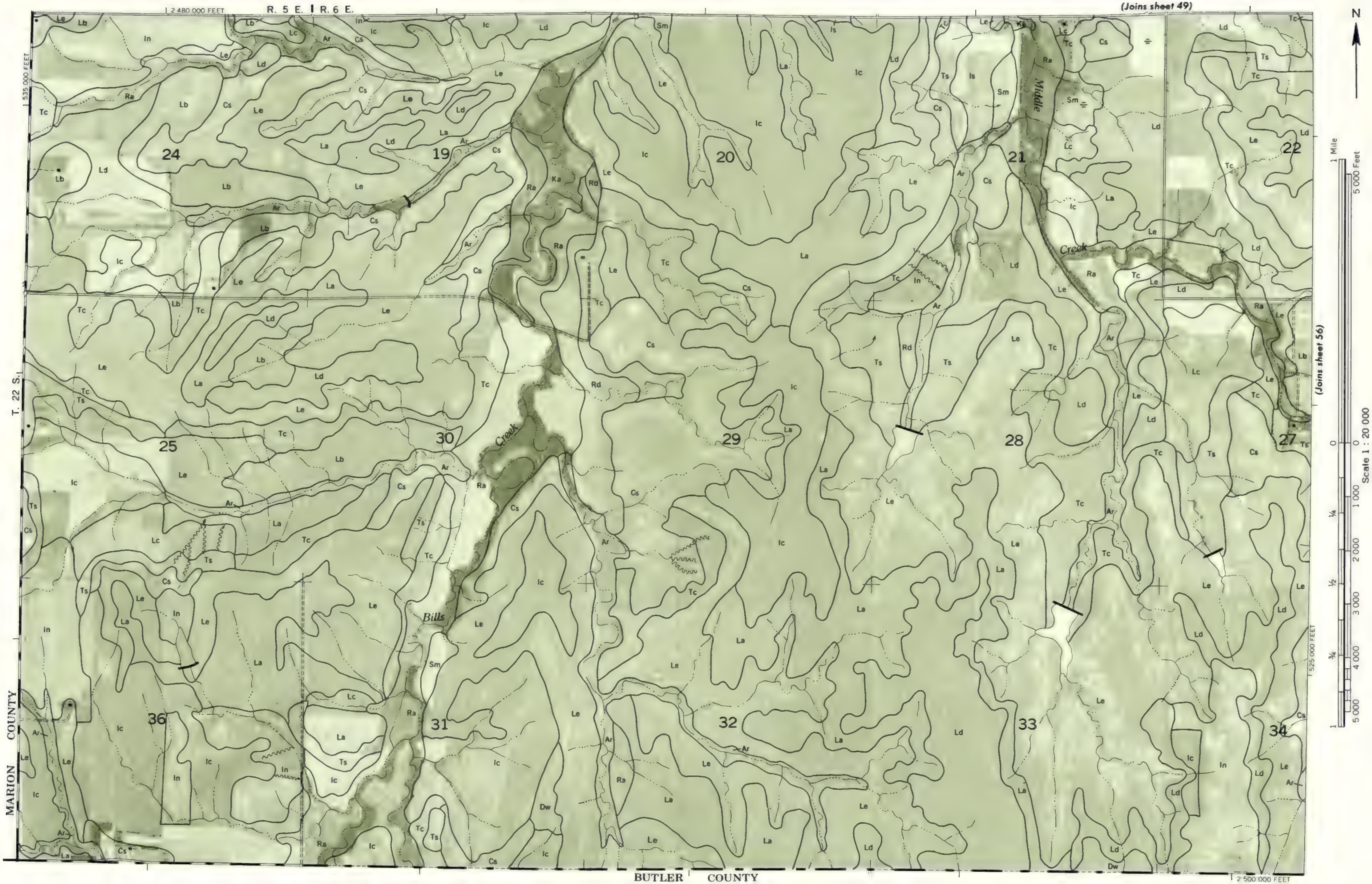
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Kansas coordinate system, south zone

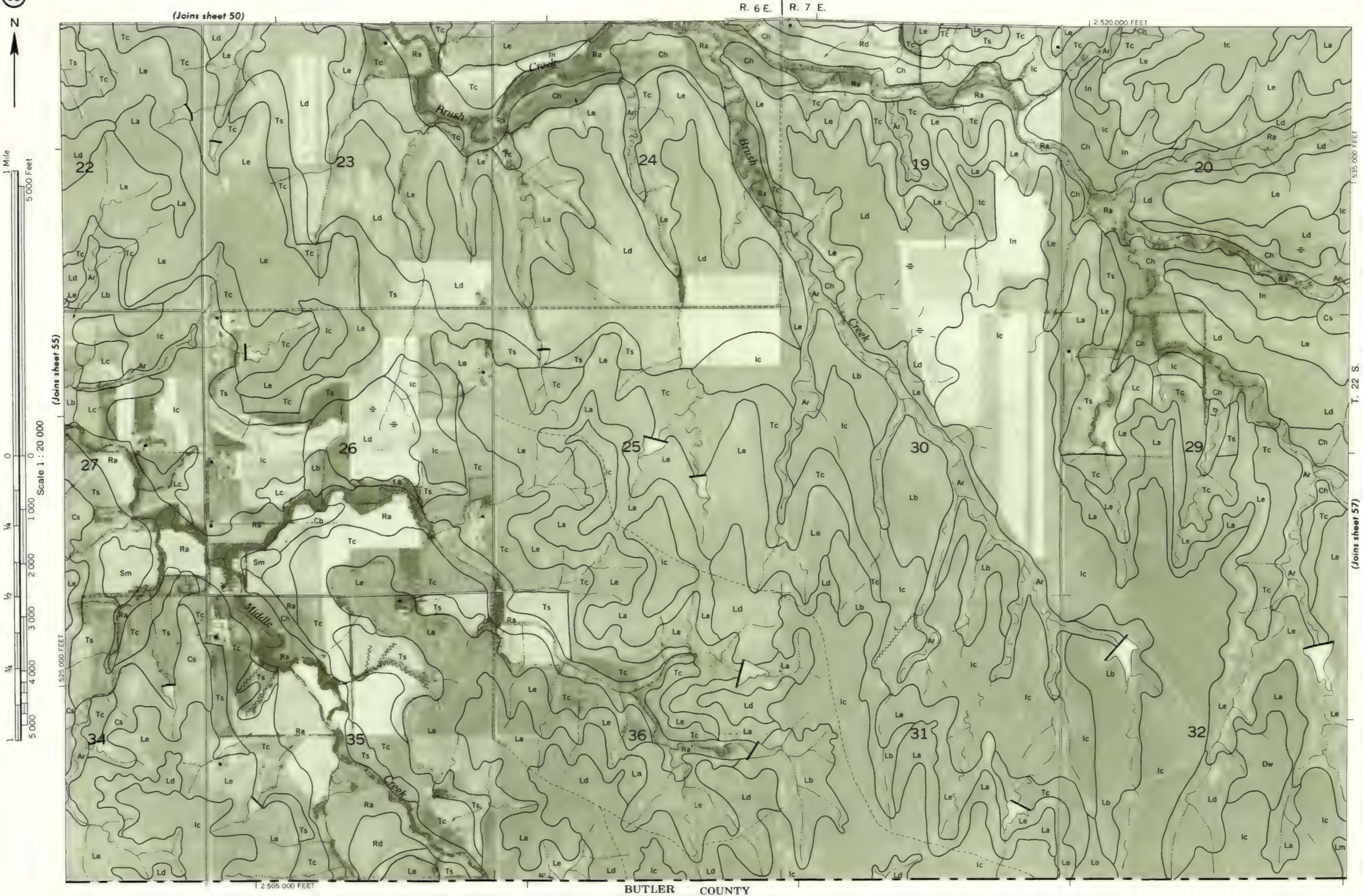
This map is one of a set compiled in 1972 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

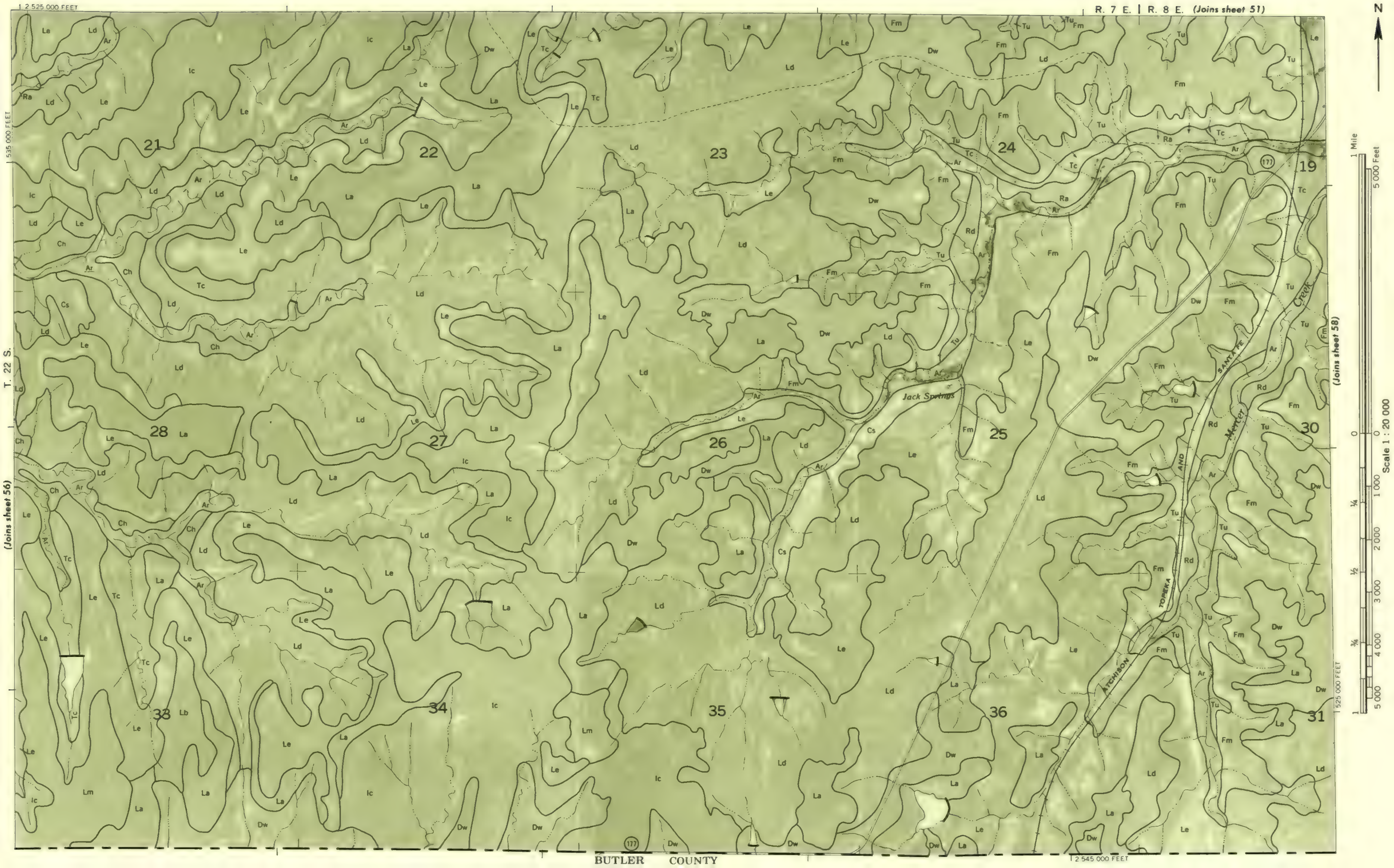
CHASE COUNTY, KANSAS NO. 52

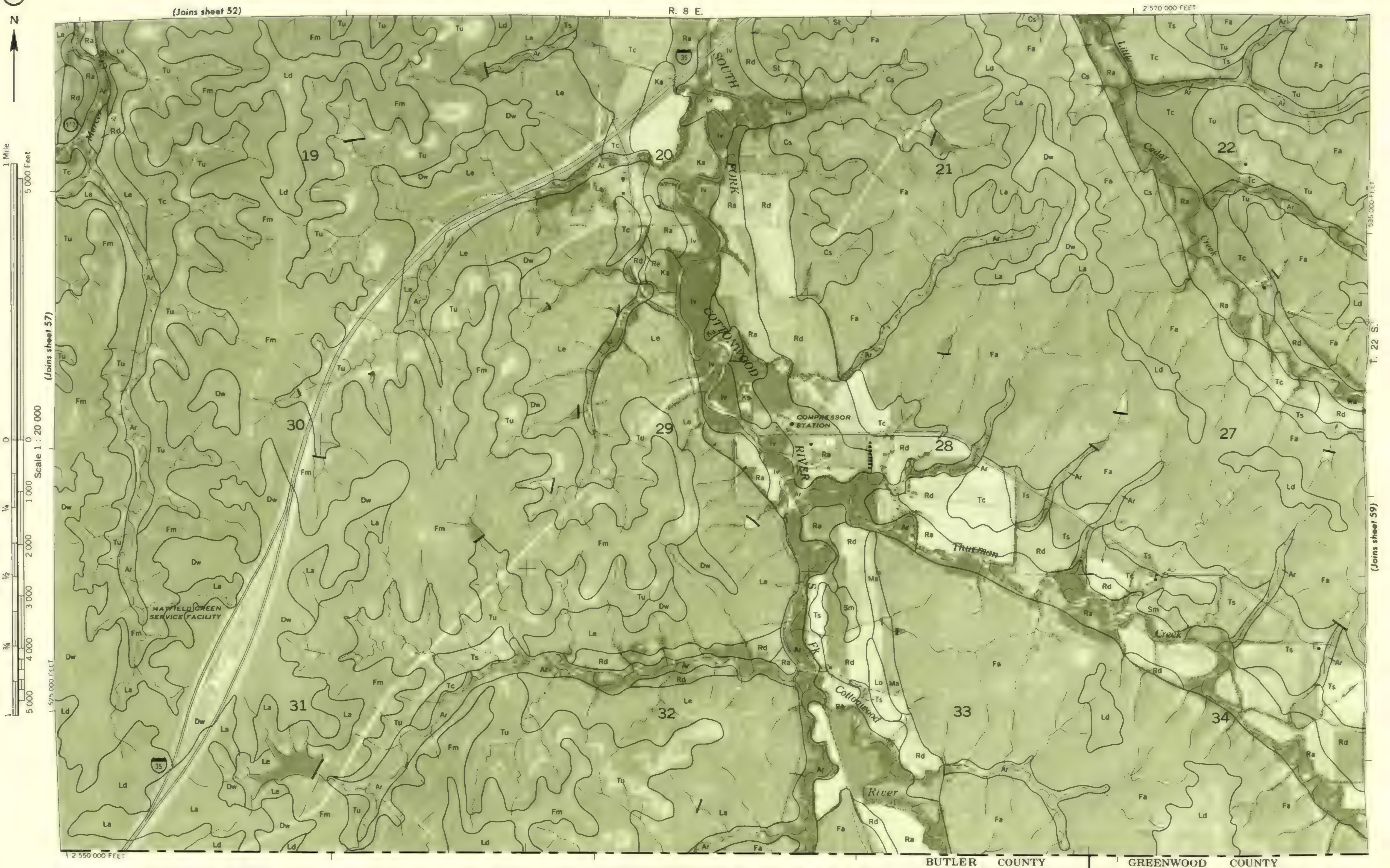
CHASE COUNTY, KANSAS – SHEET NUMBER 53

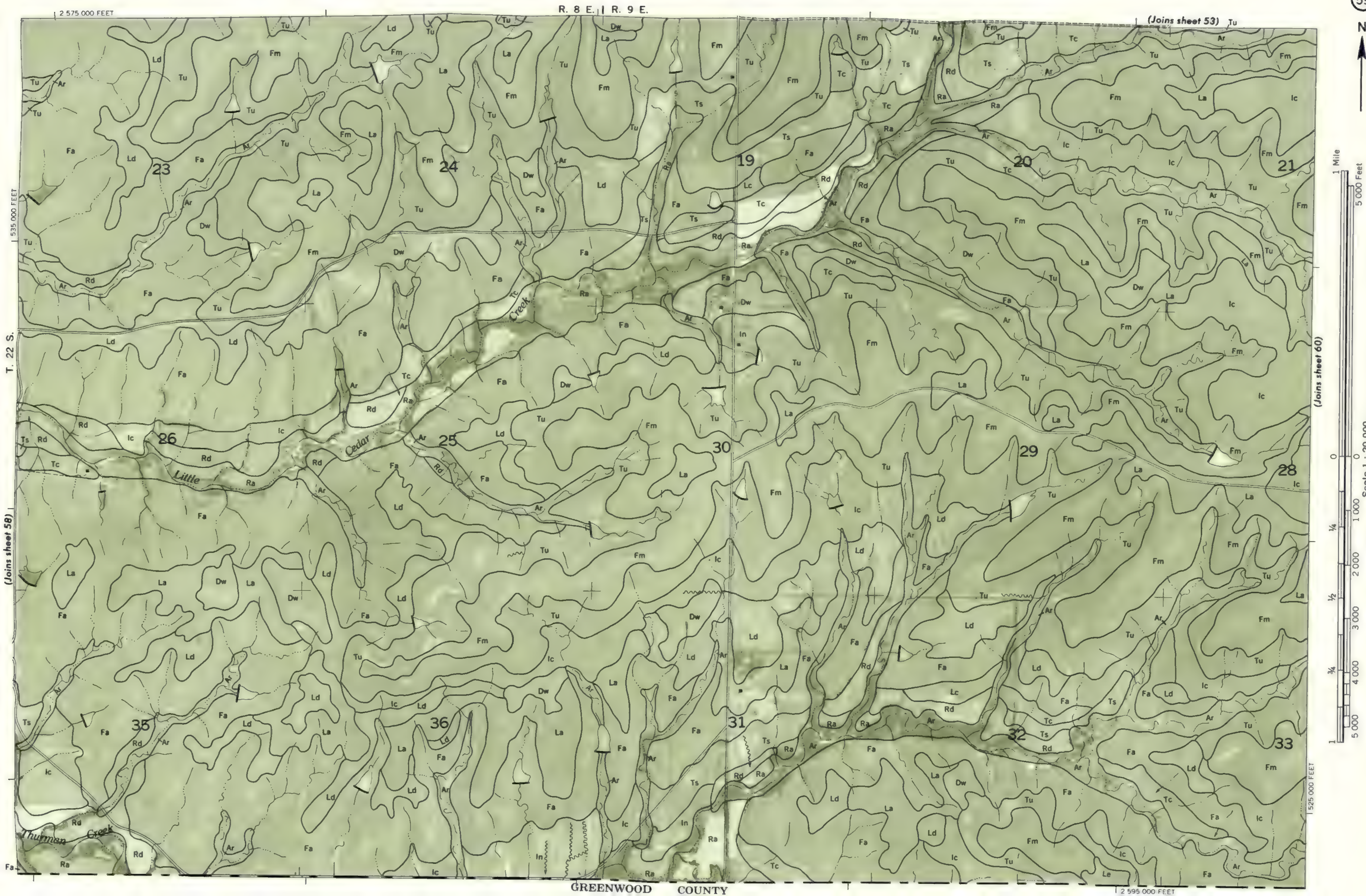

54
N
(Joins sheet 48)
R. 9 E.
2 620 000 FEET
555 000 FEET
(Joins sheet 53)
540 000 FEET
2 600 000 FEET
(Joins sheet 60)
1 Mile
5 000 Feet
Scale 1 : 20 000
0
1/4
1/2
3/4
1
0
1 000
2 000
3 000
4 000
5 000
GREENWOOD COUNTY
T. 22 S.
Verdigris River
1
2
3
4
9
10
11
12
13
14
15
16
Cs
Fa
Fm
St
Rd
Iv
Ar
Zd
Ka
Tu
Ld


2 480 000 FEET
R. 5 E.
R. 6 E.
(Joins sheet 49)
(Joins sheet 56)
535 000 FEET
525 000 FEET
2 500 000 FEET
T. 22 S.
MARION COUNTY
BUTLER COUNTY
N
1 Mile
5 000 Feet
Scale 1 : 20 000
Middle
Creek
Bills
Creek
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

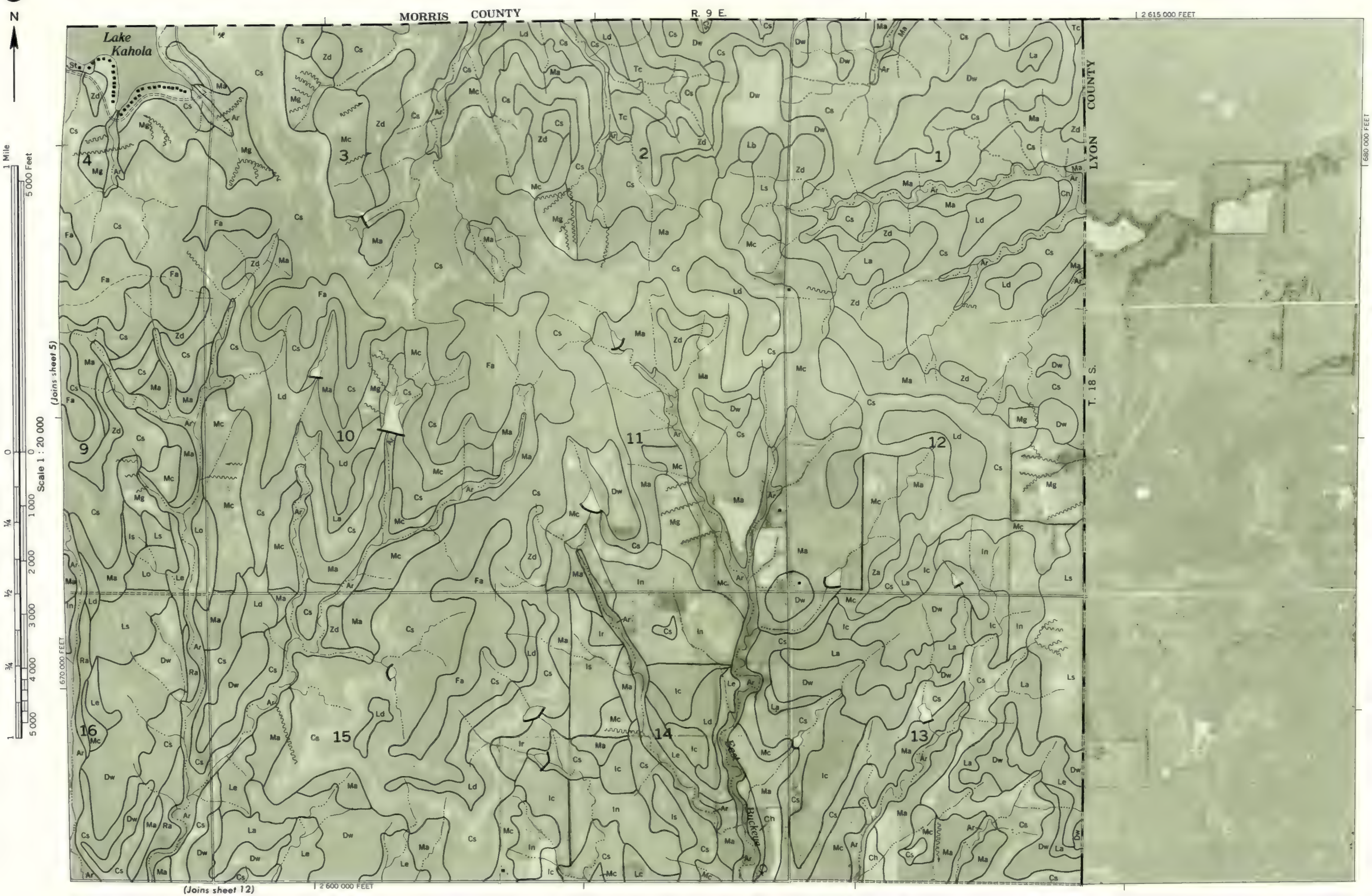

N
1 Mile
5 000 Feet
Scale 1 : 20 000
(Joins sheet 50)
(Joins sheet 55)
(Joins sheet 57)
R. 6 E.
R. 7 E.
T. 22 S.
2 520 000 FEET
535 000 FEET
525 000 FEET
2 505 000 FEET
Brush Creek
Brush Creek
Middle Creek
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36
BUTLER COUNTY

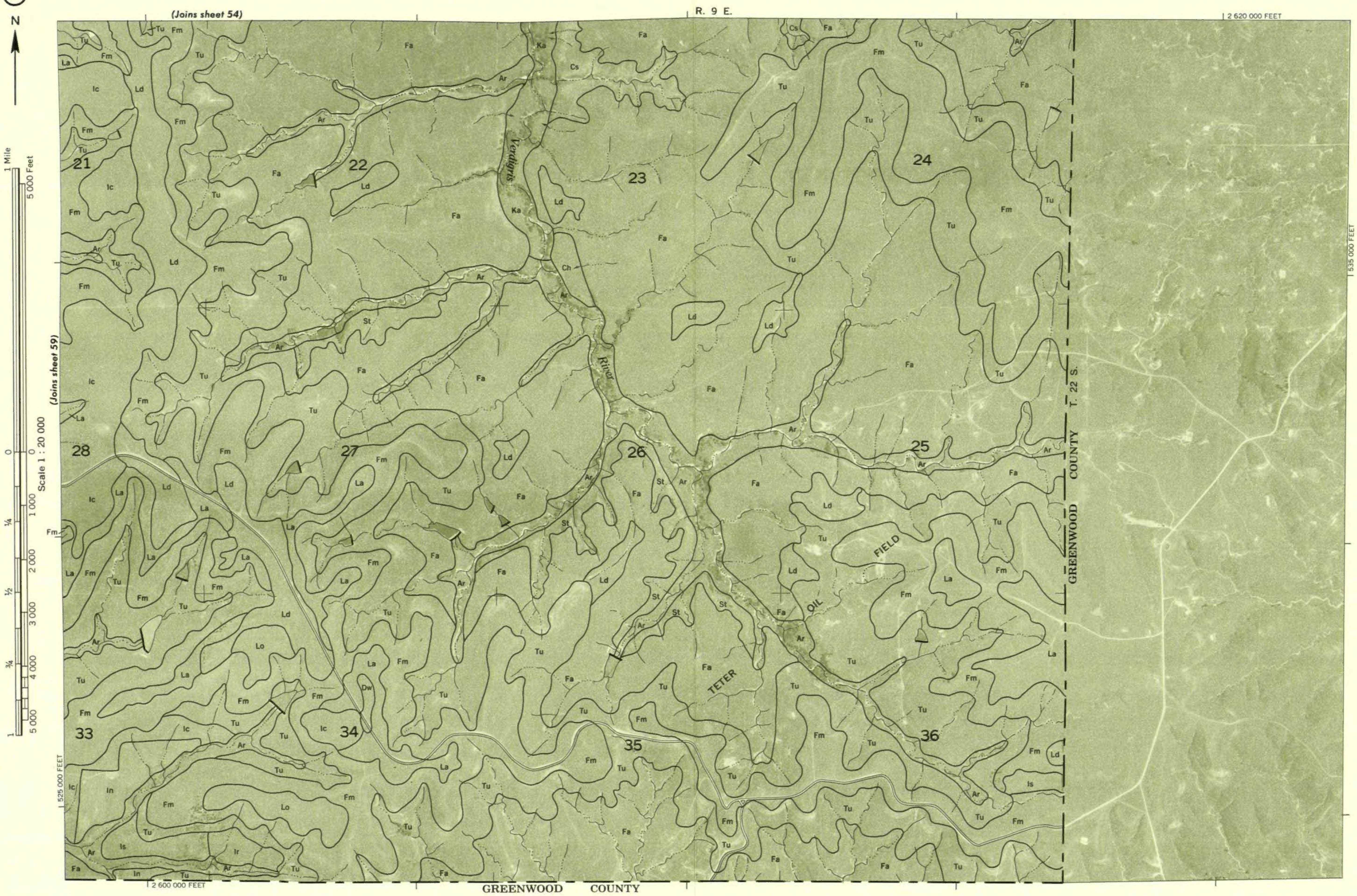

R. 7 E. | R. 8 E. (Joins sheet 51)
(Joins sheet 58)
(Joins sheet 56)
T. 22 S.
BUTLER COUNTY
Jack Springs
Mercer Creek
ATCHISON TOPEKA AND SANTA FE
177
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
N
1 Mile
5 000 Feet
Scale 1 : 20 000
1 2 525 000 FEET
535 000 FEET
525 000 FEET
2 545 000 FEET


N
(Joins sheet 52)
R. 8 E.
2 570 000 FEET
(Joins sheet 57)
(Joins sheet 59)
T. 22 S.
535 000 FEET
525 000 FEET
2 550 000 FEET
1 Mile
5 000 Feet
Scale 1 : 20 000
19
20
21
22
27
28
29
30
31
32
33
34
SOUTH
FORK
COTTONWOOD
RIVER
COMPRESSOR STATION
MATFIELD GREEN SERVICE FACILITY
Little
Cedar
Creek
Thurman
Creek
S.
Fk
Cottonwood
River
BUTLER COUNTY
GREENWOOD COUNTY


R. 8 E. | R. 9 E.
2 575 000 FEET
(Joins sheet 53)
(Joins sheet 58)
(Joins sheet 60)
T. 22 S.
535 000 FEET
525 000 FEET
2 595 000 FEET
GREENWOOD COUNTY
Little Cedar Creek
Thurman Creek
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
N
1 Mile
5 000 Feet
Scale 1 : 20 000

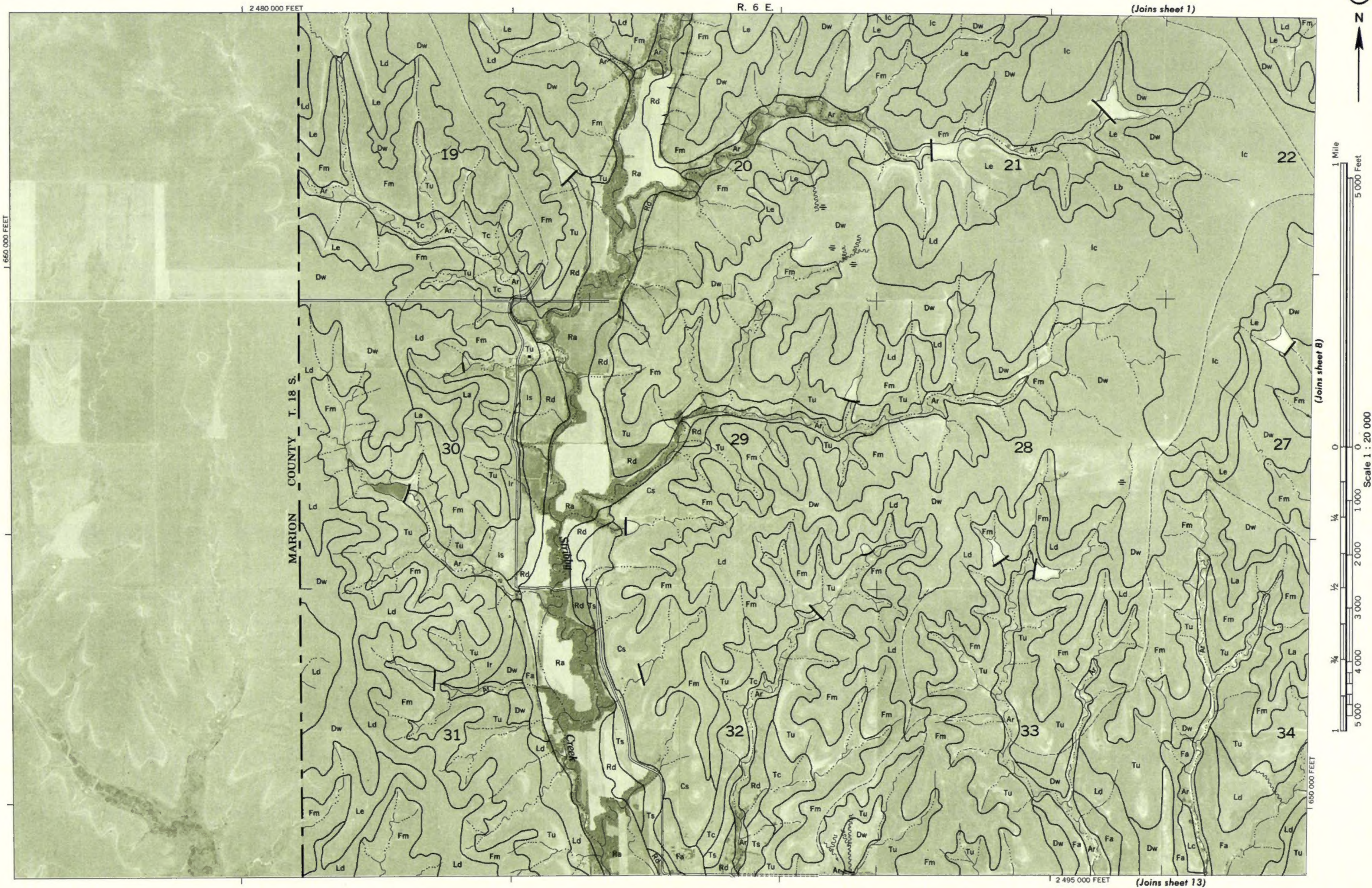
CHASE COUNTY, KANSAS — SHEET NUMBER 6

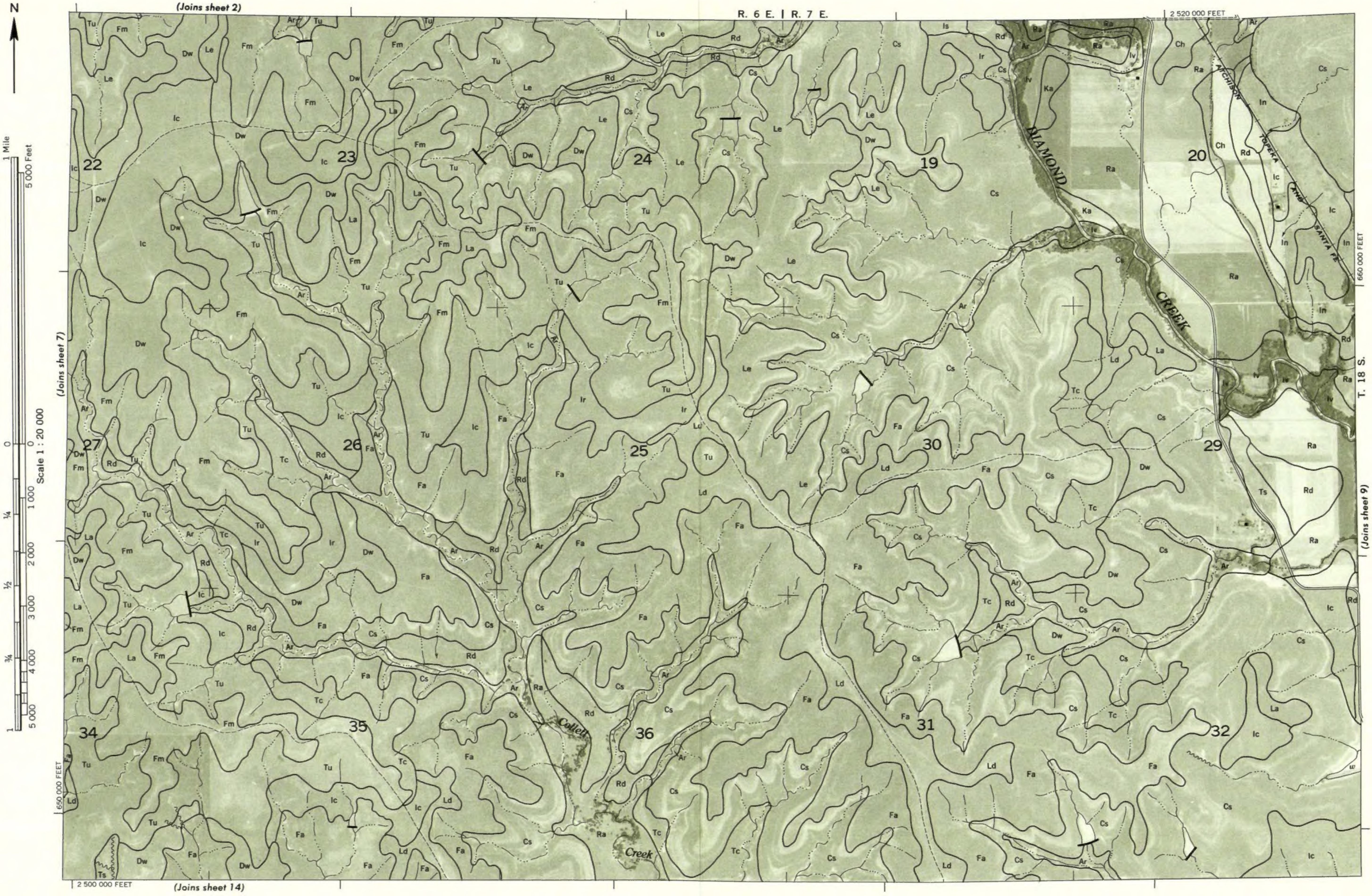


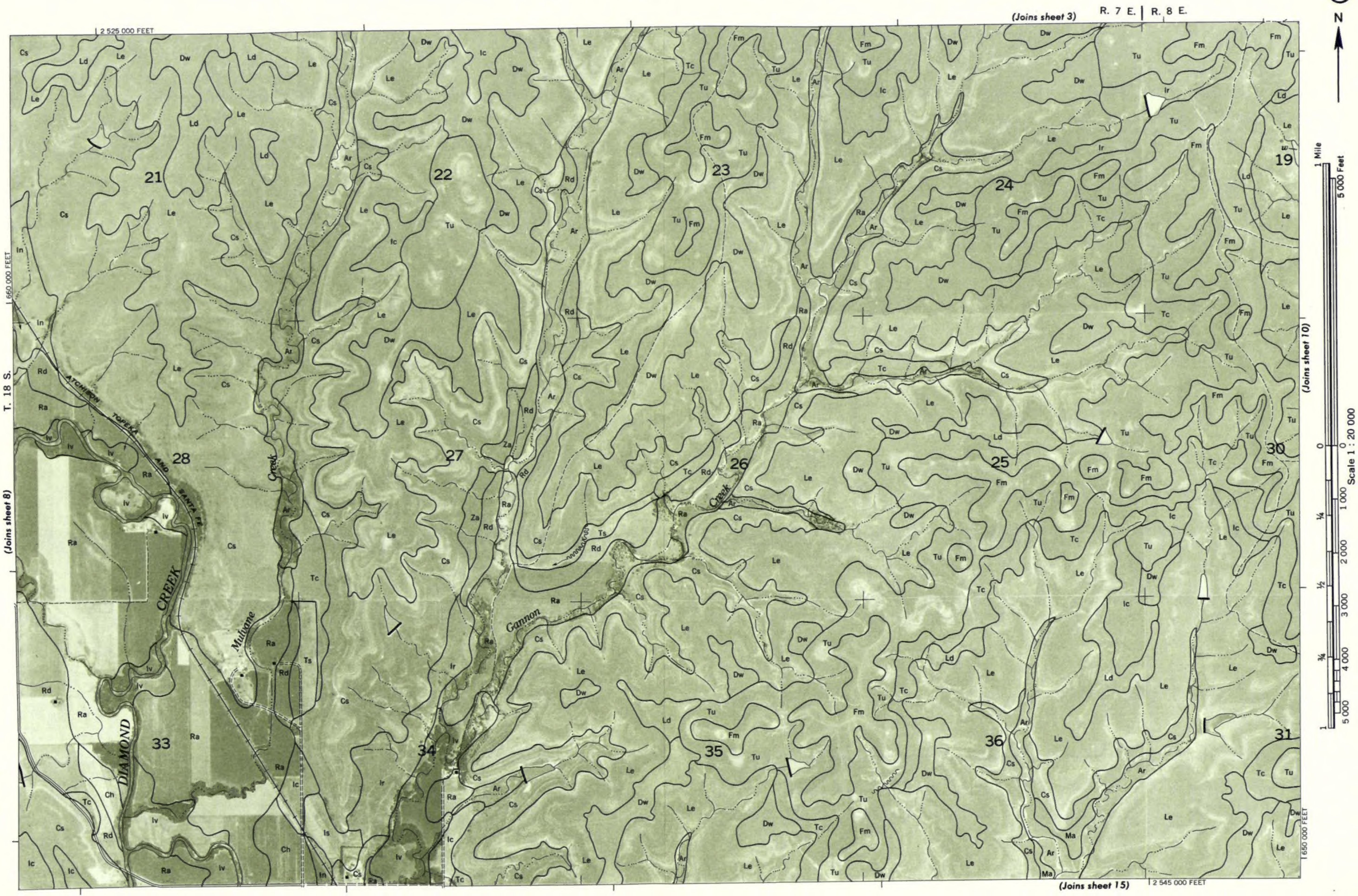

N
(Joins sheet 54)
R. 9 E.
2 620 000 FEET
(Joins sheet 59)
535 000 FEET
525 000 FEET
2 600 000 FEET
T. 22 S.
GREENWOOD COUNTY
GREENWOOD COUNTY
Verdigris River
TETER OIL FIELD
21
22
23
24
25
26
27
28
33
34
35
36
1 Mile
5 000 Feet
Scale 1 : 20 000

CHASE COUNTY, KANSAS — SHEET NUMBER 7

7




N
1 Mile
5 000 Feet
Scale 1 : 20 000
(Joins sheet 2)
R. 6 E. | R. 7 E.
2 520 000 FEET
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 14)
T. 18 S.
660 000 FEET
650 000 FEET
2 500 000 FEET
DIAMOND
CREEK
ATCHISON
TOPEKA
AND
SANTA FE
Collett
Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


9
N
(Joins sheet 3)
R. 7 E. | R. 8 E.
2 525 000 FEET
660 000 FEET
T. 18 S.
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 15)
2 545 000 FEET
650 000 FEET
ATCHISON TOPEKA AND SANTA FE
DIAMOND CREEK
Mulvane Creek
Gannon Creek
21
22
23
24
19
27
28
26
25
30
33
34
35
36
31
1 Mile
5 000 Feet
Scale 1 : 20 000
0
¼
½
¾
1
1 000
2 000
3 000
4 000
5 000